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Evaluation of Different Animal Manures on Growth and Yield of Mulberry

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Abstract

An experiment was conducted at department of Sericulture, University of Agricultural Sciences, GKVK, Bengaluru during 2022. Results of the experiment revealed that the application of sheep manure equivalent to 150 per cent N ha^{-1} recorded significantly higher available nitrogen, phosphorous, potassium and organic carbon (310.46, 68.58, 290.1 kg ha^{-1} and 0.76%), respectively in Victory-1 variety mulberry garden soil. Same treatment recorded higher plant growth parameters such as plant height (141.6 cm), number of shoot plant^{-1} (27.4), number of leaves plant^{-1} (332.1) and leaf area (162.8 cm^2), at 60 DAP. Leaf yield (70.26 t/ha/year).

Keywords : V1 bush mulberry, Animal manures, Growth parameters

Mulberry (*Morus alba* L.) is a perennial tree that is commercially exploited for its leaves to feed monophagous silkworm, *Bombyx mori* in the sericulture industry (Gerasopoulos and Stavroulakis, 1997). In India, mulberry silk accounted for 75.59 per cent (36,582 MT) of the total silk produced in 2022-23 (Anonymous, 2023). The sustainability of the sericulture industry depends on the timely availability of mulberry foliage. Mulberry for commercial silk production is maintained as bush by recurrent pruning, which ensures continuous availability of leaves at convenient manageable height.

Mulberry (*Morus alba* L.) is a fast growing deciduous woody perennial dioecious plant having deep root system and in India, mulberry is grown under varied climatic conditions ranging from temperate to tropical, covering Karnataka, Andhra Pradesh and Tamil Nadu states. In the sub-tropical zone, West Bengal, Himachal Pradesh and the north eastern states have major areas under mulberry cultivation. In India, most states have taken up sericulture as an important agro-industry with excellent results. The total area of mulberry in the country is around 282,244 ha. Mulberry foliage is the only food for the silkworm and the major economic component in sericulture. The quality and quantity of leaves have a direct bearing on cocoon harvest.

The highly intense mulberry cropping system can decrease the soil fertility and cause depletion of nutrients, if adequate care and protection are not provided to soil. Recently, it has been found that use of chemical fertilizers are affecting soil health in addition to environmental pollution, which can be avoided by using organic manures.

The prolonged application of fertilizers deteriorates the physico-chemical properties of soil and productivity. The use of organic manure has been recognized as an efficient practice for stimulation of various biological transformations in the soil leading to improvement of soil fertility and health (Siddappa Kore, 1992). Organic manures are bulky in nature but contain all the essential nutrients including micronutrients required for the growth and development of plants.

Addition of organic manures will provide dual benefit of improving tropical soil by adding nutrients and improving soil moisture retention overall enhancing

soil physical and biochemical properties. Greater opportunities exist for increased crop production by increasing the rate, timing and by improving management of mineral fertilizers (Ramachandrappa *et al.*, 2013). Organic manures like farm yard manure, sheep manure, poultry manure and pig manure stimulate the production of polysaccharides and other compounds that favours aggregation of fine soil particles, thereby promoting good structure, improved tilth, aeration, moisture movement and retention. Combined use of these manures and inorganic fertilizers is of special significance under an intensive cropping system as these are complementary and supplementary to each other in sustaining crop yields and soil productivity. FYM is the most commonly used organic manure but its supply is limited.

Sheep manure, poultry manure and pig manure can contain different amounts of nitrogen, phosphorous, potassium, sulfur and micro-nutrients which are generally not supplied by commercial fertilizers but are essential for plant growth. Manure is considered a viable source of organic matter pertinent to improve soil stability, decrease soil density and increase water retention capacity and also helps in nutrient uptake.

Material and Methods

The experiment was conducted from June 2022 to August 2022 at the Department of Sericulture, University of Agricultural Sciences, Gandhi KrishiVignana Kendra, Bengaluru. The experimental plot is laid out as per Randomized Complete Block Design (RCBD). The treatments were replicated thrice. The whole experimental plot was divided into three blocks. Each block was sub divided into 13 plots. Thus, the total number of plots was 39 (13 treatments x 3 replications). The size of each plot was 4.8 m x 3.6 m. Treatments were distributed randomly in the plots within the blocks. Application of different animal based organic manures to the mulberry garden was done at 10 days after pruning. Organic manures *viz.,* FYM at 70 t ha^{-1}, sheep manure at 11.66 t ha^{-1}, poultry manure at 11.55 t ha^{-1} and pig manure at 43.75 t ha^{-1} were applied to concerned plot.

Growth Parameters of Mulberry

Plant Height (cm) : Plant height was recorded from the base of the main shoot to the top most fully opened leaf in five randomly selected plants under each treatment, in three replications. The mean of five plants was worked out to obtain the mean plant height.

Number of Shoots Plant^{-1} : The number of branches in five randomly selected plants was counted in each plant under each replication and the mean was worked out. Mean number of shoots were calculated.

Number of Leaves Plant^{-1}: Number of leaves plant^{-1} was counted from five randomly labelled plants. Mean number of leaves were calculated and recorded.

Internodal Distance (cm) : Distance between two successive nodes was measured in centimeters of the main shoot and average internodal distance was calculated.

Leaf Area (cm^2) : Single leaf area was measured by taking length and breadth of individual leaves of different treatments in each replication. Leaf areawas calculated by factor method.

$$LA = L \times B \times 0.69$$

Where,

LA = Leaf area
L = Length
B = Breadth
0.69= Correction factor

Leaf Dry Matter Plant^{-1} (%) : Leaf dry matter was calculated at 30, 45 and 60 days after pruning by harvesting the leaves from plants in each treatment. After taking the fresh weight leaves were oven dried at 60-65 ^{o}C to obtain constant weight. The final weight of the sample after drying was weighed and expressed as per cent dry matter content (Dolma *et al.,* 2010).

$$\text{Dry matter per cent} = \frac{\text{Dry matter content (g)}}{\text{Fresh weight (g)}} \times 100$$

Yield Parameters of V1 Mulberry

Individual Leaf Weight (g) : Individual leaf weight was recorded by weighing the leaves from five

randomly selected plants at 45 days after pruning and was recorded as individual leaf weight.

Leaf Yield Plant^{-1} (g) : The leaf yield was obtained by harvesting of mulberry leaves as grams plant^{-1} from five randomly selected mulberry plants on 60 days after pruning.

Yield Hectare^{-1} (tonnes) : The leaf yield was obtained by harvesting of mulberry leaves as grams plant^{-1} from five randomly selected mulberry plants and converted into leaf yield in tonnes ha^{-1} year^{-1}.

Results and Discussion

Influence of Animal Manures on Soil Properties

The soil properties like pH, EC, available N, P_2O_5 and K_2O were analysed before (Table 1) and after the experiment to know the status of the soil in V1 mulberry garden and there was a change in the soil properties due to the application of animal manures. The above mentioned soil properties differed significantly due to application of animal manures and different doses of fertilizers, but the pH and EC was found non-significant.

Soil pH

Soil pH was found non significant among different treatment. Application of different animal manures has decreased the soil pH from 7.18 to 6.91 significantly. Among the different animal manures studied, significantly lower soil pH of 6.41 and 6.91 were recorded in the plots where poultry manure equivalent to 100% N ha^{-1} and sheep manure equivalent to 125% N ha^{-1} were applied, respectively (Table 6).

Electrical Conductivity (dS m^{-1})

The electrical conductivity of soil was found non-significant among different treatments. However, the highest electrical conductivity of 0.244 dS m^{-1} was recorded in FYM equivalent to 150% N ha^{-1} and T_9 treated plot whereas, the lowest electrical conductivity of 0.18 dS m^{-1} was observed in sheep manure equivalent to 100% N ha^{-1} and poultry manure equivalent to 100% N ha^{-1} (Table 6). Yamgar (2008) who reported that electrical conductivity of the mulberry plot was decreased from 0.78 dSm^{-1} to 0.70 dSm^{-1} after combined applications of organic fertilizers.

Available Nitrogen (kg ha^{-1})

Application of animal manures significantly improved the available soil nitrogen in the mulberry garden. The highest available nitrogen content of 310.46 kg ha^{-1} was recorded in sheep manure equivalent to 150% N ha^{-1} which was found on par with poultry manure equivalent to 100% N ha^{-1} (297.92 kg ha^{-1}), FYM equivalent to 100% N ha^{-1} (285.38 kg ha^{-1}) and poultry manure equivalent to 125% N ha^{-1} (278.13 kg ha^{-1}).

Table 1

Initial soil characteristics of the experimental site

Soil characteristics	Before the experiment	Method	Reference
	Mean value		
pH (Soil: water-1:2.5)	6.77	Potentiometric method	Jackson (1973)
Electrical conductivity (dSm^{-1})	0.25	Conductometric method	Jackson (1973)
Available N (kg ha^{-1})	232.08	Alkaline potassium permanganate method	Subbaiah and Asija (1956)
Available P_2O_5 (kg ha^{-1})	45.05	Olsen's extractant method	Jackson (1973)
Available K_2O (kg ha^{-1})	257.9	Flame photometry	Jackson (1973)
Organic carbon %	0.61	Walkley and Black's rapid titration method	Piper (1950)

Table 2

Nutrient composition of different animal manures used for study

Organic Manures	Parameters		
	Nitrogen (%)	Phosphorous (%)	Potassium (%)
Farm yard manure	0.5	0.2	0.4
Sheep manure	3.0	1.0	2.0
Poultry manure	3.03	2.63	1.4
Pig manure	0.8	0.7	0.3

Table 3

Methods followed for the elemental analysis of animal manures

Parameters	Methods	References
Nitrogen (%)	Kjeldahl's digestion and distillation method	Piper (1966)
Phosphorous (%)	Diacid digestion and colorimetry using vanadom olybdate reagent	Piper (1966)
Potassium (%)	Flame photometry	Piper (1966)

Whereas, the lowest nitrogen content was recorded in pig manure equivalent to 150% N ha^{-1} (239.56 kg ha^{-1}) (Table 6). The results are supported by Sakthivel *et al.* (2021) reported that higher available nitrogen content of 233 kg ha^{-1} was recorded in Sheep penning + 50 per cent reduction in recommended doses of NPK and *Azospirillum* 2 kg and Phosphobacteria 2 kg/ac/each crop. And also results are supported by application of organic manures at higher dose than the recommendation improved the N, P and K status of soil. It was mainly due to mineralization of nitrogen from organic manures through increased activity of soil microorganisms. Sudheendra Saunshi *et al*. (2014). This might also be due to slow and steady release of nutrients from FYM and enriched Bio digested liquid manure application. These results corroborate with the findings of Vasanthi *et al.* (2023). Higher nutrient availability due to enhanced microbial activity lead to mineralization and release of nutrients matching with crop demand and better uptake of nutrients by providing favourable environment.

Available Phosphorous (kg ha^{-1})

Available phosphorus content was significantly influenced by the application of animal manures in soil of mulberry garden. Among the different treatments, the highest available phosphorus content of soil (68.58 kg ha^{-1}) was recorded in sheep manure equivalent to 150% N ha^{-1} which was found on par with poultry manure equivalent to 100% N ha^{-1} (66.89 kg ha^{-1}) followed by FYM equivalent to 100% N ha^{-1} (58.06 kg ha^{-1}) and poultry manure equivalent to 125% N ha^{-1} (56.80 kg ha^{-1}). Whereas, available phosphorus was lowest in pig manure equivalent to 150% N ha^{-1} (46.10 kg ha^{-1}) (Table 6).The results are supported by Sakthivel *et al.* (2021) reported that available phosphorous content of 27.86 kg ha^{-1} was highest recorded in Sheep penning + 50 per cent reduction in recommended doses of NPK and *Azospirillum* 2 kg and Phosphobacteria 2 kg/ac/each crop over control.

Table 4

Methods followed for the analysis of plant samples

Parameters	Methods	References
Nitrogen (%)	Micro Kjeldahl's method	Piper, 1966
Phosphorous (%)	Spectrophotometry	Piper, 1966
Potassium (%)	Flame photometry	Piper, 1966

Available Potassium (kg ha^{-1})

Application of animal manures significantly enhanced the available potassium content in soil. Among the different treatments, highest available potassium content of soil (290.1 kg ha^{-1}) was recorded in sheep manure equivalent to 150% N ha^{-1} which was found on par with poultry manure equivalent to 100% N ha^{-1} (289.3 kg ha^{-1}) followed by FYM equivalent to 100% N ha^{-1} (287.3 kg ha^{-1}) and poultry manure equivalent to 125% N ha^{1} (280.1 kg ha^{-1}). Whereas, available potassium was lowest in pig manure equivalent to 150% N ha^{-1} (260.1kg ha^{-1}) (Table 6). The results are supported by Sakthivel *et al.* (2021)

Table 5

Treatment details

T_1	FYM equivalent to 100% RDN/ha of mulberry
T_2	FYM equivalent to 125% RDN/ha of mulberry
T_3	FYM equivalent to 150% RDN/ha of mulberry
T_4	Sheep manure equivalent to 100% RDN/ha of mulberry
T_5	Sheep manure equivalent to 125% RDN/ha of mulberry
T_6	Sheep manure equivalent to 150% RDN/ha of mulberry
T_7	Poultry manure equivalent to 100% RDN/ha of mulberry
T_8	Poultry manure equivalent to 125% RDN/ha of mulberry
T_9	Poultry manure equivalent to 150% RDN/ha of mulberry
T_{10}	Pig manure equivalent to 100% RDN/ha of mulberry
T_{11}	Pig manure equivalent to 125% RDN/ha of mulberry
T_{12}	Pig manure equivalent to 150% RDN/ha of mulberry
T_{13}	100% Recommended dose of fertilizer + FYM (as per package of practice) – control

*RDN- Recommended dose of Nitrogen

reported that higher available potassium content of 258 kg ha^{-1} was recorded in Sheep penning + 50 per cent reduction in recommended doses of NPK over control (RDF).

Organic Carbon (%)

Application of animal manures significantly enhanced the organic carbon content in soil. Among the different treatments, highest available soil organic carbon content of (0.76 %) was recorded in sheep manure equivalent to 150% N ha^{-1} which was found on par with poultry manure equivalent to 100% N ha^{-1} (0.75 %) followed by FYM equivalent to 100% N ha^{-1} (0.72%) and poultry manure equivalent to 125% N ha^{-1} (0.70 %). Whereas, organic carbon was the lowest in pig manure equivalent to 150% N ha^{-1} (0.65%) (Table 6). Patiram and Singh (1993) reported that improvement in organic carbon content of soil with incorporation of goat manure, organic carbon increased from 0.89 per cent to 1.19 per cent. Similar

Table 6

Post harvest soil properties of mulberry garden as influenced by application of animal manure

Treatments	pH	EC (dS m^{-1})	N (kg ha^{-1})	P_2O_5 (kg ha^{-1})	K_2O (kg ha^{-1})	OC %
Initial values	6.77	0.25	232.08	45.05	257.9	0.610
T_1	7.08	0.22	285.38	58.06	287.3	0.720
T_2	7.18	0.21	259.56	53.11	277.2	0.682
T_3	6.98	0.24	260.29	54.17	278.5	0.690
T_4	7.14	0.18	249.45	50.46	275.2	0.668
T_5	7.41	0.21	250.16	53.03	280.4	0.677
T_6	6.98	0.22	310.46	68.58	290.1	0.750
T_7	6.91	0.18	297.92	66.89	289.3	0.766
T_8	6.93	0.19	278.13	56.80	280.1	0.700
T_9	6.96	0.24	240.11	46.28	261.4	0.648
T_{10}	7.18	0.21	245.78	49.46	270.5	0.658
T_{11}	6.99	0.20	243.12	47.65	267.2	0.655
T_{12}	7.16	0.19	239.56	46.10	260.1	0.650
T_{13}	7.09	0.22	254.23	52.35	277.4	0.678
F test	NS	NS	*	*	*	*
S. Em±	0.297	0.014	5.367	1.154	5.411	0.014
CD at 5 %	-	-	15.757	3.387	15.889	0.041

result was recorded by Obi and Ebo (1995) reported that the application of 100 per cent of organic fertilizer in the form of poultry manure at 10 t ha^{-1} has significantly increased the soil organic matter.

Growth Parameters of V1 Mulberry

The data on growth parameters of Victory 1 mulberry as influenced by application of animal manures under irrigated condition are presented below.

Plant Height (cm)

Application of different animal manures recorded significant difference on plant height at 30, 45 and 60 Days after Pruning (DAP) and it is presented in Table 7. However, higher plant height of 74.54 cm was recorded in sheep manure equivalent to 150% N ha^{-1} which was found on par with poultry manure equivalent to 100% N ha^{-1} (72.81 cm) followed by FYM equivalent to 100% N ha^{-1} (71.65 cm). Whereas, plant height was lowest in pig manure equivalent to 150% N ha^{-1} (52.61 cm) at 30 DAP. Significantly higher plant height of 129.76 cm was recorded in sheep manure equivalent to 150% N ha^{-1} which was found on par with poultry manure equivalent to 100% N ha^{-1} (126.95 cm) and FYM equivalent to 100% N ha^{-1} (124.43 cm). Whereas, plant height was lowest in pig manure equivalent to 150% N ha^{-1} (96.56 cm) at 45 DAP. Similar trend was noticed in plant height of V1 mulberry at 60 DAP where significantly higher plant height of 141.65 cm was recorded in sheep manure equivalent to 150% N ha^{-1} which was found on par with poultry manure equivalent to 100% N ha^{-1} (138.86 cm) and FYM equivalent to 150% N ha^{-1} (135.30 cm). Whereas, plant height was lowest in pig manure equivalent to 150% N ha^{-1} applied plot (123.29 cm) (Table 7). Similar results were observed by Padmaja (2008) who reported that in M5 variety, the maximum average shoot height of 52.66 cm was recorded with the sheep manure treatment at 15 t/ha. This result is also in conformity with Chakrabarty *et al*. (2016) and Siddappa Kore (1992).

Table 7

Plant height in V-1 mulberry as influenced by application of different animal manures

Treatments	Plant height (cm)		
	30 DAP	45 DAP	60 DAP
T_1	71.65	124.43	135.30
T_2	68.26	120.25	130.79
T_3	69.58	120.91	131.56
T_4	60.31	117.67	128.47
T_5	63.80	118.12	130.30
T_6	74.54	129.76	141.65
T_7	72.81	126.95	138.86
T_8	70.15	125.54	135.96
T_9	53.64	114.47	125.85
T_{10}	55.79	114.53	125.52
T_{11}	56.02	116.06	126.46
T_{12}	52.61	112.36	123.29
T_{13}	65.34	118.96	130.01
F test	*	*	*
S. Em±	1.324	2.417	2.640
CD at 5 %	3.887	7.097	7.752

DAP- Days After Pruning, *- Significant

Number of Shoots Plant^{-1}

The number of shoots plant^{-1} was statistically analysed for different Days after Pruning (DAP). Significantly higher number of shoots plant^{-1} of (20.16) was recorded in mulberry applied with sheep manure equivalent to 150% N ha^{-1} followed by poultry manure equivalent to 100% N ha^{-1} (19.95) and FYM manure equivalent to 100% N ha^{-1} (19.07). Whereas, number of shoots plant^{-1} was the lowest in pig manure equivalent to 150% N ha^{-1} applied plot (14.38) at 30 DAP. Significantly a greater number of shoots (23.61) was recorded in sheep manure equivalent to 150% N ha^{-1} which was found on par with poultry manure equivalent to 100% N ha^{-1} (23.17) and FYM equivalent to 100% N ha^{-1} (22.52). Whereas, number of shoots plant^{-1} was lowest in pig manure equivalent to 150% N ha^{-1} (15.09) at 45 DAP. Similar trend was noticed in number of shoots plant^{-1} of mulberry at 60 DAP whereas significantly higher number of shoots plant^{-1} was recorded in sheep manure equivalent to 150% N ha^{-1} (27.45) which was found on par with poultry manure equivalent to 100% N ha^{-1} (27.22) and

FYM equivalent to 100% N ha^{-1} (26.49). Whereas, number of shoots plant^{-1} was lowest in pig manure equivalent to 150% N ha^{-1} applied plot (19.01) (Table 8). Similar observations were made by Siddappa Kore (1992) application of sheep manure to irrigated mulberry garden resulted in higher number of shoots per plant (13.7). The increase in number of branches due to organic manures could be attributed to improved root system of plants resulting in absorption of more water and nutrients and its utilization. The positive influence of organic manures on number of branches could be due to increase in shoot length and vigor. The addition of organic manures has solubilizing effect on plant nutrients resulting in their availability (Subbiah *et al.,* 1982). These findings are in conformity with the results reported by Shelke *et al*. (1999).

Table 8

Number of shoots plant^{-1} in V-1 mulberry as influenced by application of different animal manures

Treatments	Number of shoots/plant		
	30 DAP	45 DAP	60 DAP
T_1	19.07	22.52	26.49
T_2	18.41	19.79	23.46
T_3	18.52	20.18	24.28
T_4	17.35	18.15	22.42
T_5	17.99	18.70	22.72
T_6	20.16	23.61	27.45
T_7	19.95	23.17	27.22
T_8	18.98	20.21	25.38
T_9	15.19	16.80	23.37
T_{10}	17.15	18.08	21.98
T_{11}	16.33	17.38	21.85
T_{12}	14.38	15.09	19.01
T_{13}	18.27	19.41	23.13
F test	*	*	*
S. Em±	0.480	0.554	0.672
CD at 5 %	1.409	1.628	1.974

DAP- Days After Pruning, *- Significant

Number of Leaves Plant^{-1}

The data on the number of leaves plant^{-1} recorded at different days after pruning (DAP) revealed that the number of leaves plant^{-1} was found significant at 30, 45 and 60 DAP. However, at 30 DAP the mulberry plot applied with sheep manure equivalent to 150% N ha^{-1} has recorded higher number of leaves plant^{-1} (190.22) which was found on par with poultry manure equivalent to 100% N ha^{-1} (189.15) followed by FYM equivalent to 100% N ha^{-1} (185.11). Whereas, number of leaves plant^{-1} was lowest in pig manure equivalent to 150% N ha^{-1} applied plot (150.97). Significantly a higher number of leaves plant^{-1} (255.33) was recorded in sheep manure equivalent to 150% N ha^{-1} which was found on par with poultry manure equivalent to 100% N ha^{-1} (245.71) and FYM equivalent to 100% N ha^{-1} (232.40). Whereas, number of leaves plant^{-1} was lowest in pig manure equivalent to 150% N ha^{-1} (195.26) at 45 DAP. Similar trend was noticed at 60 DAP where higher number of leaves plant^{-1} was recorded in sheep manure equivalent to 150% N ha^{-1} (343.85) which was found on par with poultry manure equivalent to 100% N ha^{-1} (340.15) and FYM equivalent to 100% N ha^{-1} (339.68). Whereas, the lowest number of leaves was recorded in pig manure equivalent to 100% N ha^{-1} applied plot (273.55) (Table 9). The significant increase in number of leaves was observed in mulberry (V-1) in winter season with both farm yard manure treatment and farmers' practice. Improved number of leaves with the application of both organic and inorganic manures was earlier reported by Ravi Kumar (2003). Similar result by winter season, application of farmers' practice, farm yard manure treatment at 20 t/ha, sheep manure treatment at 15 t/ha and poultry manure treatment at 15 t/ha recorded significantly maximum number of leaves of 34.90, 33.66, 30.93 and 29.40, respectively. The minimum number of leaves were recorded with the control (20.80). The results are in line with Chakrabarty *et al*. (2016) who reported that highest number of shoots per plant of 6.04 was recorded in mulberry (S1) treated with poultry-manure 7 MT/ha/yr + (*Azotobacter* 20kg + 75kg N + 30kg P_2O_5 and 50 kg K_2O)/ha/yr to control.

Table 9

Number of leaves plant^{-1} in V-1 mulberry as influenced by application of different animal manures

Treatments	Number of leaves/plant		
	30 DAP	45 DAP	60 DAP
T_1	185.11	231.89	325.26
T_2	175.03	225.41	299.51
T_3	179.15	229.76	303.48
T_4	168.29	216.21	288.37
T_5	170.26	219.96	291.40
T_6	190.22	250.30	332.12
T_7	189.15	241.58	328.50
T_8	180.45	230.77	324.30
T_9	159.87	199.15	271.56
T_{10}	165.43	213.17	286.55
T_{11}	160.60	201.74	284.81
T_{12}	150.97	195.26	264.00
T_{13}	170.72	220.34	295.06
F test	*	*	*
S. Em±	3.382	4.566	13.96
CD at 5 %	9.930	13.406	41.00

DAP- Days After Pruning, *- Significant

Table 10

Internodal distance in V-1 mulberry as influenced by application of different animal manures

Treatments	Number of shoots/plant		
	30 DAP	45 DAP	60 DAP
T_1	5.47	5.57	5.70
T_2	5.50	5.83	6.53
T_3	5.47	5.63	6.13
T_4	5.80	5.87	5.87
T_5	5.73	5.77	6.80
T_6	5.07	5.20	5.50
T_7	5.30	5.37	5.57
T_8	5.53	5.60	6.10
T_9	6.33	6.47	6.53
T_{10}	5.90	6.07	6.13
T_{11}	6.03	6.17	5.80
T_{12}	6.73	6.80	6.83
T_{13}	5.60	5.77	5.87
F test	*	*	*
S. Em±	0.201	0.141	0.130
CD at 5 %	0.591	0.413	0.383

DAP- Days After Pruning, *- Significant

Internodal Distance (cm)

The internodal distance of V1 mulberry variety was statistically significant for different days after pruning (DAP). However, lower internodal distance of 5.07 cm was recorded in mulberry applied with sheep manure equivalent to 150% N ha^{-1} which was found on par with poultry manure equivalent to 100% N ha^{-1} treated plot (5.30 cm) and FYM equivalent to 150% N ha^{-1} (5.47 cm). Whereas, internodal distance was highest in pig manure equivalent to 150% N ha^{-1} applied plot (6.73 cm) at 30 DAP. The lesser internodal distance of 5.20 cm was recorded in sheep manure equivalent to 150% N ha^{-1} which was found on par with poultry manure equivalent to 100 % N ha^{-1} treated plot (5.37 cm) and FYM equivalent to 150% N ha^{-1} (5.57 cm). Whereas, internodal distance was highest in pig manure equivalent to 150% N ha^{-1} applied plot (6.80 cm) at 45 DAP.

Leaf Area (cm^2)

The statistical analysis of leaf area was recorded at different days after pruning (DAP) revealed that leaf area of V1 mulberry variety was found to be significant at 30 DAP. However, maximum leaf area of 96.40 cm^2 was recorded in mulberry applied with sheep manure equivalent to 150% N ha^{-1} which was found on par with poultry manure equivalent to 100% N ha^{-1} (90.80 cm^2) followed by FYM equivalent to 100% N ha^{-1} (85.80 cm^2). Whereas, leaf area was minimum in pig manure equivalent to 150% N ha^{-1} applied plot (65.90 cm^2). Significantly maximum leaf area of 129.8 cm^2 and 162.8 cm^2 was recorded in sheep manure equivalent to 150% N ha^{-1} which was found on par poultry manure equivalent to 100% N ha^{-1} (127.6 cm^2 and 160 cm^2) followed by FYM equivalent to 100% N ha^{-1} (125.5 cm^2 and 154.0 cm^2). Whereas,

Minimum leaf area was recorded in pig manure equivalent to 150% N ha^{-1} applied plot (106.2 cm^2 and 121.4 cm^2) at 45 and 60 DAP, respectively (Table 11). The results are supported by Padmaja (2008) who reported maximum leaf area (188.19 sq. cm and 182.60 sq. cm) were recorded in mulberry (V1) applied with the FYM at 20 t/ha + NPK (100:50:50) followed by sheep manure treatment at 15 t/ha during the summer season over control. Similar trend was noticed in internodal distance of V1 mulberry at 60 DAP where lesser internodal distance of 5.50 cm was recorded in sheep manure equivalent to 150% N ha^{-1} which was found on par with poultry manure equivalent to 100% N ha^{-1} treated plot (5.57 cm) and FYM equivalent to 150% N ha^{-1} (5.70 cm). Whereas, internodal distance was highest in pig manure equivalent to 150% N ha^{-1} applied plot (6.83 cm) at 60 DAP.

Table 11

Leaf area (cm^2) of V1 mulberry as influenced by application of animal manures

Treatments	Leaf area (cm^2)		
	30 DAP	45 DAP	60 DAP
T_1	85.80	125.7	154.0
T_2	80.10	121.8	142.1
T_3	81.23	122.7	143.9
T_4	70.60	117.0	131.5
T_5	78.73	119.9	139.2
T_6	96.40	129.8	162.8
T_7	90.80	127.6	160.0
T_8	82.40	124.0	150.8
T_9	68.25	112.7	124.4
T_{10}	70.10	116.1	129.0
T_{11}	69.58	115.6	128.7
T_{12}	65.90	106.2	121.4
T_{13}	79.48	121.4	140.6
F test	*	*	*
S. Em±	1.493	2.342	3.795
CD at 5 %	4.382	6.876	11.14

DAP- Days After Pruning, *- Significant

Leaf Dry Matter (%)

Application of organic manures significantly influenced the leaf dry matter content for different days after pruning (DAP). The maximum leaf dry matter of 25.69 per cent was recorded in sheep manure equivalent to 150% N ha^{-1} which was found on par with poultry manure equivalent to 100% N ha^{-1} (25.40 %). Whereas, the lowest leaf dry matter of 19.04 per cent was recorded in pig manure equivalent to 150% N ha^{-1} at 30 DAP. Similar trend was noticed at 45 and 60 DAP where maximum leaf dry matter per cent of 26.84 per cent and 37.38 per cent was recorded in sheep manure equivalent to 150% N ha^{-1} followed by poultry manure equivalent to 100% N ha^{-1} (26.20 and 35.41 per cent) Whereas, the lowest leaf dry matter of 24.85 and 25.09 per cent was recorded in poultry manure equivalent to 150% N ha^{-1}, respectively (Table 12). The results are supported by Sharma (2009) who reported the sheep manure at

Table 12

Leaf dry matter in V1 mulberry as influenced by application of animal manures

Treatments	Leaf dry matter %		
	30 DAP	45 DAP	60 DAP
T_1	24.42	25.16	33.77
T_2	23.23	23.74	27.53
T_3	23.78	24.18	28.84
T_4	21.33	21.94	25.88
T_5	22.88	22.96	24.74
T_6	25.69	26.84	37.38
T_7	25.40	26.20	35.41
T_8	24.01	24.82	33.46
T_9	19.90	20.55	25.11
T_{10}	20.63	20.80	25.85
T_{11}	19.96	20.21	25.43
T_{12}	19.04	20.08	24.34
T_{13}	22.94	23.62	27.42
F test	*	*	*
S. Em±	0.332	0.319	0.967
CD at 5 %	0.974	0.936	2.841

DAP- Days After Pruning, *- Significant

10 t/ha significantly increased the green fodder dry matter to the extent of 21, 22.1 per cent, respectively in fodder oats.

Leaf Yield and Yield Attributing Parameters of V1 Mulberry Variety

The individual leaf weight at 45 DAP and yield of V1 mulberry plant at 60 DAP were significantly superior in mulberry plot applied with sheep manure equivalent to 150% N ha^{-1} (2.47 g $leaf^{-1}$), (1011.76 g $plant^{-1}$) and (70.26 tonnes ha^{-1} $year^{-1}$) which was found on par with poultry manure equivalent to 100% N ha^{-1} (2.41 g $leaf^{-1}$), (949.65 g $plant^{-1}$) and (65.94 tonnes ha^{-1} $year^{-1}$), respectively compared to rest of the treatments. Whereas, pig manure equivalent to 150% N ha^{-1} has recorded lower individual leaf weight of 1.74 g $leaf^{-1}$ and leaf yield of 530.54 g $plant^{-1}$ and 36.84 tonnes ha^{-1} $year^{-1}$ (Table 13). The present results are in line with earlier studies of Sakthivel *et al.* (2021) who reported an increase in leaf yield (59.18 MT/ha/year) with all sheep pent gardens, comparable to unpent gardens. It might be due to application of organic manures exhibited higher yields than those applied with synthetic fertilizer, this could be attributed to large quantities of available nitrogen, available phosphorus and available potassium per kilogram in the manure. The result are also in conformity with Siddappa Kore (1992) and Zarate *et al.* (1997).

Table 13

Leaf yield and yield attributing parameters in V1 mulberry as influenced by application of animal manures

Treatments	45 DAP	60 DAP	
	Average single leaf weight (g)	Yield $plant^{-1}$ (g)	Yield ha^{-1} $year^{1}$ (tonnes)
T_1	2.33	916.03	63.61
T_2	2.19	821.70	57.06
T_3	2.24	832.24	57.79
T_4	2.10	734.53	51.01
T_5	2.14	798.87	55.47
T_6	2.47	1011.76	70.26
T_7	2.41	949.65	65.94
T_8	2.29	908.99	63.12
T_9	1.84	643.44	44.68
T_{10}	2.07	674.45	46.83
T_{11}	2.05	705.22	48.97
T_{12}	1.74	530.54	36.84
T_{13}	2.17	804.82	55.89
F test	*	*	*
S. Em±	0.088	83.17	5.776
CD at 5 %	0.259	244.22	16.959

DAP- Days After Pruning, *- Significant

A field experiment was conducted to study the Evaluation of different animal organic manures on growth, yield and quality of mulberry and rearing performance of silkworm (*Bombyx mori* L.). The results of the study are summarized in this chapter.

Soil pH was found non-significant, but higher pH (7.41) was recorded in sheep manure equivalent to 100% N ha^{-1}. Electrical conductivity was found non-significant, but higher EC (0.24 dS m^{-1}) was recorded in poultry manure equivalent to 150% N ha^{-1}. Available nitrogen, phosphorus, potassium and organic carbon (310.46 kg ha^{-1}, 68.58 kg ha^{-1}, 290.1 kg $ha^{-1}$and 0.766%) are significantly higher in sheep manure equivalent to 150% N ha^{-1}, respectively.

Application of animal manure to mulberry garden shows higher plant growth attributes. Sheep manure equivalent to 150% N ha^{-1} was recorded significant difference on plant height (74.54 cm, 129.76 cm and 141.65 cm) and number of shoots (20.16, 23.61 and 27.45) at 30, 45 and 60 DAP, respectively. The internodal distance of plant was found significant at 30, 45, 60 DAP (5.07, 5.20, 5.50). The number of leaves $plant^{-1}$ at 30, 45, 60 DAP was found significant (190.22, 250.30, 332.12). Leaf area was found significant at 30, 45, 60 DAP (96.40 cm^2, 129.8 cm^2, 162.8 cm^2), respectively in sheep manure equivalent to 150% N ha^{-1}.

Significantly higher leaf dry matter (25.69, 26.84 and 37.38 %) was recorded in sheep manure equivalent to 150% N ha^{-1}. Significantly higher individual leaf weight, leaf yield $plant^{-1}$ and leaf yield ha^{-1} $year^{-1}$ (2.47 g, 1011.76 g and 70.26 tonnes) were recorded in

mulberry garden applied with sheep manure equivalent to 150% N ha^{-1} compared to pig manure equivalent to 150% N ha^{-1} havingindividual leaf weight, leaf yield $plant^{-1}$ and leaf yield ha^{-1} $year^{-1}$(1.74 g, 530.54 g and 36.84 tonnes), respectively.

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