Annals of Plant and Soil Research 26(2): 228-233 (2024)
https://doi.org/10.47815/apsr.2024.10354

Impact of organic fertilizers on morphological characteristics of giloy (*tinospora cordifolia*) in Jharkhand

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Received, March, 2024; Revised accepted, April, 2024

ABSTRACT

Tinospora cordifolia (Willd.) Hook. f. & Thoms., commonly known as Giloy, belonging to the family Menispermaceae and is an important medicinal plant. The plants of Tinospora cordifolia were planted in Randomized Block Design (RBD) with 12 treatments and 3 replications in a plot size of 2 m x 2 m at a spacing level of 100 cm x 100 cm. The experiment was conducted at the Botanical Garden, PG Department of Botany, Vinoba Bhave University, Hazaribag (Jharkhand). The plant is used in Ayurvedic "Rasayanas" to improve the immune system and the body's resistance against infections. Four seedlings were transplanted into each plot for each treatment. The useful part of this plant is the stem and the effectiveness of its medicinal value depends upon its thickness. The objective of this research work to find out the impact of organic fertilizer on the morphological characteristics (including stem thickness) of the Giloy plant. Maximum stem diameter (20.67 mm) was recorded from the application of Farm Yard Manure (FYM) 10 t ha^{-1}. Hence, it can be concluded that Farm Yard Manure (FYM) was best for the commercial cultivation of the Giloy plant.

Keywords: Giloy, *Tinospora cordifolia,* Organic, fertilizers, Morphology

INTRODUCTION

Tinospora cordifolia (Willd.) Hook.f. & Thoms., commonly named "Guduchi" in Sanskrit and Giloy in Hindi, belongs to the family Menispermaceae (Kumari *et al.,* 2024) and is one of the important dioecious plants distributed throughout the tropical Indian subcontinent and China (Sharma *et al.,* 2013). It's a genetically diverse, large, deciduous climbing shrub with greenish yellow typical flowers found at lower to higher altitudes. The stem of this plant is succulent, long, filiform, fleshy, and climbing in nature, with a creamy white to gray colour. The leaves of this plant are simple, alternate, stipulate, long petiole, heart-shaped, and twisted partially. The young aerial roots are long, filiform, and threadlike, which arise from the mature branches or cut stems growing downward and, by continuously lengthening, sometimes reach the ground. The male flowers are clustered, and the females are solitary. The flowering season expands over summers and winters (Upadhyay *et al.,* 2010). Fruits develop during the winter, and their seeds are curved in shape (Shetty *et al.,* 2010). Stem cuttings are the best planting material for raising a commercial crop. Guduchi is an Indian wild medicinal plant and has been used in ayurvedic preparation for the treatment of various ailments. It is used as a rasayana to improve the immune system and body resistance against infections. It is a traditional belief that *Giloy-satva* obtained from the Giloy plant growing on the neem tree (*Azadirachta indica*) is more bitter and efficacious and is said to incorporate the medicinal values of neem (Sinha *et al.,* 2004).

In Jharkhand, because of the acidic soil, micro- and macronutrients are not available to plants. Therefore, the growth of the Giloy plant is being affected. The application of organic fertilizers would be helpful in improving the physical and chemical properties of the soil. Organic nutrient management is essential in enhancing the yield per unit area. The soil should be well drained with sufficient moisture and rich with organic matter for the growth of the Giloy plant (Jitendra *et. al.,* 2014). Organic fertilizer application aims to maintain or adjust soil fertility for Giloy cultivation. It involves using manures, vermicompost, neem cake, karunj cake, mustard cake, mahua cake, etc. and biological agents to achieve sustainable crop production, and improved soil health. Still, there exists some controversy over the optimum dose of organic fertilizer for better morphological characters during the cultivation of Giloy plants. The main objective of this research was to

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determine the impact of organic fertilizer on the morphological characteristics of Giloy (*Tinospora cordifolia*).

MATERIALS AND METHOD

The experimental site is located in the Botanical Garden of Vinoba Bhave University, Hazaribag (Jharkhand), which is located between 23.9933° N latitude and 85.3620° E longitude. The altitude is about 610 m above the mean sea level. The temperature varies from 24.4^{0}C to 39.2^{0}C and humidity varies from 10.8% to 98.3%. The annual rainfall of Hazaribag district is 1255 mm. Due to the presence of iron, the soil is red type (Kumari *et al.,* 2024). The soil colour of study area is a little red, brown, and yellow. The plant Giloy (*Tinospora cordifolia*) was planted in Randomized Block Design (RBD) with 12 treatments and 3 replications in a plot size of 2 m x 2 m at spacing of 100 cm x 100 cm. The number of plants kept in a treatment was 4. Sometimes the recommended doses of fertilizers (RDF) are not effective, due to rise in average temperature during the fruit set stage (Srivastava, 2023). Hence, different varieties and doses of organic fertilizers were used as a treatment that is shown in Table 1.

Table 1: Details of treatments

Treatments	Organic Fertilizers used as treatment	Dose of organic fertilizers (tone/ha)
T_1	Control	Nothing
T_2	Farm Yard Manure (FYM)	10 t ha^{-1} (Recommended)
T_3	Farm Yard Manure (FYM)	5 t ha^{-1}
T_4	Vermicompost	5 t ha^{-1}
T_5	Sunflower Cake	5 t ha^{-1}
T_6	Mahua Cake	5 t ha^{-1}
T_7	Linseed Cake	5 t ha^{-1}
T_8	Karanj Cake	5 t ha^{-1}
T_9	Mustered Cake	5 t ha^{-1}
T_{10}	Neem Cake	5 t ha^{-1}
T_{11}	Azotobactor	5 g/plant
T_{12}	Tricoderma	5 g/plant

RESULTS AND DISCUSSION

This research work was carried out to find out the effect of organic fertilizers on growth of Giloy plant. Technically find out the best organic fertilizers to obtain maximum stem diameter of Giloy plant.

Stem bark colour, Leaf lamina shape, Leaf colour, Flower colour, Sex type and Flower arrangement:

Pale green colour of stem bark colour was observed in treatment-5 as the fertilizer application of sunflower cake: 5 t ha^{-1} and treatment-1 that was control and grey bark colour was observed in 6 treatments (T_2- FYM: 10 t ha^{-1}, T_3- FYM: 5 t ha^{-1}, T_7- Linseed Cake: 5 t ha^{-1}, T_{10}- Neem Cake: 5 t ha^{-1}, T_{11}- Azotobactor: 5 g/plant and T_{12}- Tricoderma: 5 g/plant) while grayish green was observed in 2 treatments (T_4- Vermicompost: 5 t ha^{-1} and T_6- Mahua Cake: 5 t ha^{-1}) and yellowish grey was also observed in 2 treatments (T_8- Karanj Cake: 5 t ha^{-1} and T_9- Mustard Cake: 5 t ha^{-1}). Khosa & Prasad (1971) also observed that the bark colour of the Giloy plant was creamy white to grey in colour and deeply left spirally. All 12 treatments showed green stem colour at young stage. Chopra (1994) was also reported that young stems of Giloy plants are green with smooth surfaces and swelling at nodes, while the older ones show a light brown surface marked with warty protuberances due to circular lenticels transversely smoothened surface shows a radial structure with conspicuous medullary rays traversing porous tissues tastes bitter.

Three types of leaf lamina shape were observed in 12 treatments. Among 12 treatments, the most of the leaf lamina shape of Giloy was cordate, as observed in 6 treatments (T_2 - FYM: 10 t ha^{-1}, T_5 - Sunflower Cake: 5 t ha^{-1}, T_7 - Linseed Cake: 5 t ha^{-1}, T_8 - Karanj Cake: 5 t ha^{-1}, T_{10} - Neem Cake: 5 t ha^{-1} and T_{12} - Tricoderma: 5 gm/plant). Ovate-cordate shape of leaf lamina was observed in 4 treatments (T_1 - Control, T_3 - FYM: 5 t ha^{-1}, T6 - Mahua Cake: 5 t ha^{-1} and T_{11} - Azotobactor:

5 gm/plant) and broadly ovate in 2 Treatments (T_4 - Vermicompost: 5 t ha^{-1} and T_9 - Mustard Cake: 5 t ha^{-1}). Nasreen *et al.,* (2010) also observed that the leaves of this plant are membranous, simple, alternate, round, pulvinate, heart-shaped, and twisted partially. The leaves are membranous and cordate (Sharma, 2003). Four types of leaf colour were recorded in 12 treatments. Pale green colour of leaf was observed in 4 treatments (T_3- FYM: 5 t ha^{-1}, T_5- Sunflower Cake: 5 t ha^{-1}, T_8- Karanj Cake: 5 t ha^{-1} and T_{10}- Neem Cake: 5 t ha^{-1}), and dark green was observed in 4 treatments (T_2- FYM: 10 t ha^{-1}, T_4- Vermicompost: 5 t ha^{-1}, T_6- Mahua Cake: 5 t ha^{-1} and T_9- Mustard Cake: 5 t ha^{-1}), whereas greenish yellow colour was also observed in 4 treatments (T_1- Control, T_7- Linseed Cake: 5 t ha^{-1}, T_{11}- Azotobactor: 5 g/plant and T_{12}- Tricoderma: 5 g/plant). Nitrogen availability was found to be highest with the use of bio- and organic fertilizers as nutrition sources (Nath *et al.,* 2023). Nitrogen is a major component of chlorophyll. Hence, the application of organic fertilizers enhances the greenish colour of leaves and stems.

Table 2: Stem bark colour, Leaf lamina shape, Leaf colour, Flower colour, Sex type and Flower arrangement

Treatments	Stem bark colour	Leaf lamina shape	Leaf colour	Flower colour	Sex type	Flower arrangement
T_1	Pale green	Ovate-cordate	Greenish yellow	Yellow	Dioecious	Solitary (Male)
T_2	Grey	Cordate	Dark green	Yellow green	Dioecious	Solitary (Male)
T_3	Grey	Ovate-cordate	Pale green	Yellow	Dioecious	Solitary (Male)
T_4	Greyish green	Broadly ovate	Dark green	Yellow green	Dioecious	Solitary (Male)
T_5	Pale green	Cordate	Pale green	Yellow green	Dioecious	Solitary (Male)
T_6	Greyish green	Ovate-cordate	Dark green	Yellow green	Dioecious	Solitary (Male)
T_7	Grey	Cordate	Greenish yellow	Yellow green	Dioecious	Solitary (Male)
T_8	Yellowish grey	Cordate	Pale green	Yellow	Dioecious	Solitary (Male)
T_9	Yellowish grey	Broadly ovate	Dark green	Yellow green	Dioecious	Solitary (Male)
T_{10}	Grey	Cordate	Pale green	Yellow	Dioecious	Solitary (Male)
T_{11}	Grey	Ovate-cordate	Greenish yellow	Yellow green	Dioecious	Solitary (Male)
T_{12}	Grey	Cordate	Greenish yellow	Yellow green	Dioecious	Solitary (Male)

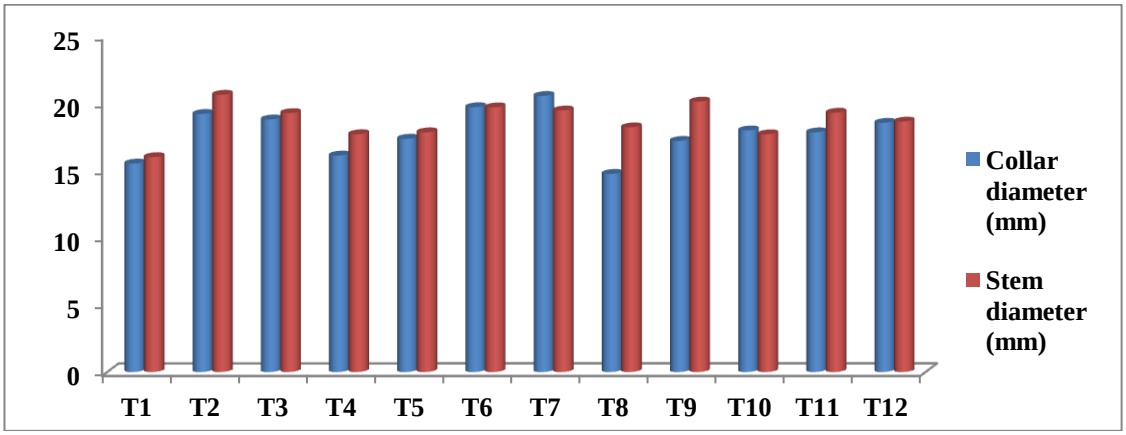
The majority of the flower colour was yellow-green, as observed in 8 treatments (T_2- FYM: 10 t ha^{-1}, T_4- Vermicompost: 5 t ha^{-1}, T_5- Sunflower Cake: 5 t ha^{-1}, T_6- Mahua Cake: 5 t ha^{-1}, T_7- Linseed Cake: 5 t ha^{-1}, T_9- Mustard Cake: 5 t ha^{-1}, T_{11}- Azotobactor: 5 g/plant and T_{12}- Tricoderma: 5 g/plant) while yellow flowers colour were observed in 4 treatments (T_1- Control, T_3- FYM: 5 t ha^{-1}, T_8- Karanj Cake: 5 t ha^{-1}, and T_{10}- Neem Cake: 5 t ha^{-1}), as shown in Table 2. All flower arrangements were solitary, with the dioecious type of sex that was observed in all treatments (T_1-Control, T_2- FYM: 10 t ha^{-1} T_3- FYM: 5 t ha^{-1}, T_4- Vermicompost: 5 t ha^{-1}, T_5- Sunflower Cake: 5 t ha^{-1}, T_6- Mahua Cake: 5 t ha^{-1}, T_7- Linseed Cake: 5 t ha^{-1}, T_8- Karanj Cake: 5 t ha^{-1}, T_9- Mustard Cake: 5 t ha^{-1}, T_{10}- Neem Cake: 5 t ha^{-1}, T_{11}- Azotobactor: 5 g/plant and T_{12}- Tricoderma: 5 g/plant)

Percentage of Survival (%), Days to flower initiation, Days to 50% flowers, Collar diameter (mm) and Stem diameter (mm)

The maximum 100.00 % survival percentage was recorded for 08 treatments (T_2- FYM: 10 t ha^{-1}, T_3- FYM: 5 t ha^{-1}, T_5- Sunflower Cake: 5 t ha^{-1}, T_7- Linseed Cake: 5 t ha^{-1}, T_8- Karanj Cake: 5 t ha^{-1}, T_9- Mustard Cake: 5 t ha^{-1}, T_{10}- Neem Cake: 5 t ha^{-1}, T_{11}- Azotobactor: 5 g/plant and T_{12}- Tricoderma: 5 g/plant) but the lowest survival percentage (64.5883.33%) was shown in treatment-8 (Karanj Cake: 5 t ha^{-1}). It was found that treatment-7 (T_7- Linseed Cake: 5 t ha^{-1}) took the minimum amount of time, i.e., 67.67 days and 86.33 days, to initiate and complete 50 % of flowering respectively. It was also observed that treatment 1 (control) took the maximum time, i.e., 78.33 days and 97.33 days, to initiate and complete 50% of flowering respectively. The grand mean value of flower initiation time and 50% flowering completion time were calculated as 73.267 days and 92.333 days, respectively.

Table 3: Percentage of Survival (%), Days to flower initiation, Days to 50% flowers, Collar diameter (mm) and Stem diameter (mm)

Treatments	Treatments Detail	Percentage of Survival (%)	Days to flower initiation	Days to 50% flowering	Collar diameter (mm)	Stem diameter (mm)
T_1	Control	91.67	78.33	97.33	15.54	16.02
T_2	FYM: 10 t ha^{-1}	100.00	71.33	90.67	19.24**	20.67**
T_3	FYM: 5 t ha^{-1}	100.00	73.67	92.67	18.83*	19.30*
T_4	Vermicompost: 5 t ha^{-1}	91.67	75.00	91.67	16.14	17.73
T_5	Sunflower Cake: 5 t ha^{-1}	100.00	70.67	93.67	17.39	17.87
T_6	Mahua Cake: 5 t ha^{-1}	91.67	72.67	92.67	19.74**	19.73
T_7	Linseed Cake: 5 t ha^{-1}	100.00	67.67	86.33	20.58**	19.50**
T_8	Karanj Cake: 5 t ha^{-1}	83.33	77.67	93.00	14.77	18.24
T_9	Mustard Cake: 5 t ha^{-1}	100.00	71.00	89.00	17.23	20.16**
T_{10}	Neem Cake: 5 t ha^{-1}	100.00	74.00	95.33	18.01	17.72
T_{11}	Azotobactor: 5 gm/plant	100.00	74.67	95.67	17.87	19.33*
T_{12}	Tricoderma: 5 gm/plant	100.00	71.33	90.00	18.58	18.67
	Grand Mean	96.528	73.167	92.333	17.827	18.744
	SEM	6.112	1.910	2.015	0.597	0.330
	CD at 5%	NS	3.890	4.104	1.216	0.673
	CD at 1%	NS	NS	NS	1.418	0.784
	CV %	10.967	4.522	3.780	5.802	3.052



Graph 1: Showing the collar and stem diameter

Highly significant maximum collar diameter (20.58 mm) was recorded from treatment-7 (Linseed Cake: 5 t ha^{-1}), followed by 19.74 mm (T_6- Mahua Cake: 5 t ha^{-1}), 19.24 mm (T_2- FYM: 10 t ha^{-1}), and minimum (14.77 mm) were recorded from treatment-8 (Karanj Cake: 5 t ha^{-1}) while the grand mean value of collar diameter was calculated as 17.67 mm. The significant collar diameter of 18.83* mm was calculated from treatment-3 (T_3- FYM: 5 t ha^{-1}). The significant variations were observed in different physiochemical properties of the soil (Dedhia *et al.,* 2023). We were also observed, highly significant variation in collar and stem diameter due to application of different types of organic fertilizers. Maximum stem diameter (20.67 mm) was recorded from treatment-2 (FYM: 10 t ha^{-1}), followed by 19.50 mm (T_7- Linseed Cake: 5 t ha^{-1}), which are highly significant values. Whereas the minimum (16.02 mm) was recorded from control while the grand mean value of collar diameter was calculated as 18.74 mm. The significant stem diameter of 19.33 mm and 19.30 mm were calculated from treatment-11 (Azotobactor: 5 g/plant) and treatment-3 (FYM: 5 t ha^{-1}).

Internodal distance (cm), Leaf length (cm), leaf width (cm) and petiole length (cm):

Maximum intermodal distance (14.43 cm) was recorded from treatment-7 (Linseed Cake: 5 t ha^{-1}), followed by 14.31 cm (T_4-

Vermicompost: 5 t ha^{-1}), 14.04 cm (T_{10}- Neem Cake: 5 t ha^{-1}), 14.02 cm (T_8- Karanj Cake: 5 t ha^{-1}), and 13.99 cm (T_{11}- Azotobactor: 5 g/plant). Whereas the minimum (12.47 cm) was recorded from treatment-2 (FYM: 10 t ha^{-1}) while the grand mean value of intermodal distance was calculated as 13.763 cm.

Table 4: Internodal distance (cm), Leaf length (cm), leaf width (cm) and petiole length (cm) of Giloy plants

Treatments	Treatments Detail	Internodal distance (cm)	Leaf length (cm)	Leaf width (cm)	Petiole length (cm)
T_1	Control	13.74	9.06	8.86	3.99
T_2	FYM: 10 t ha^{-1}	12.47	9.40	10.11	4.40
T_3	FYM: 5 t ha^{-1}	13.70	8.80	9.68	4.27
T_4	Vermicompost: 5 t ha^{-1}	14.31	7.87	9.37	4.58*
T_5	Sunflower Cake: 5 t ha^{-1}	13.62	8.66	9.22	4.16
T_6	Mahua Cake: 5 t ha^{-1}	13.43	9.57	9.53	4.31
T_7	Linseed Cake: 5 t ha^{-1}	14.43**	10.74**	11.60**	4.68*
T_8	Karanj Cake: 5 t ha^{-1}	14.02	9.14	9.29	4.24
T_9	Mustered Cake: 5 t ha^{-1}	13.85	9.62	9.97	4.53
T_{10}	Neem Cake: 5 t ha^{-1}	14.04	10.68**	10.26	4.31
T_{11}	Azotobactor: 5 gm/plant	13.99	9.86	9.75	4.11
T_{12}	Tricoderma: 5 gm/plant	13.55	10.48*	10.44	4.36
	Grand Mean	13.763	9.489	9.839	4.327
	SEM	0.277	0.429	0.344	0.118
	CD at 5%	0.564	0.874	0.701	0.240
	CD at 1%	0.658	1.019	0.817	NS
	CV %	3.487	7.834	6.056	4.710

Maximum petiole length (4.68 cm) was recorded from treatment-7 (Linseed Cake: 5 t ha^{-1}), followed by 4.58 cm (T_4- Vermicompost: 5 t ha^{-1}), 4.53 cm (T_6- Mustered Cake: 5 t ha^{-1}), 4.40 cm (T_2- FYM: 10 t ha^{-1}), and 4.36 cm (T_{12}- Tricoderma: 5 g/plant). Whereas the minimum (3.99 cm) was recorded from control (T_1), while the grand mean value of petiole length was calculated as 4.327 cm. The maximum leaf length and leaf width of the Giloy plant were 10.74 cm and 11.60 cm, respectively, observed in treatment-7 (Linseed Cake: 5 t ha^{-1}). Minimum leaf length and leaf width were 8.80 cm and 8.86 cm in treatment-3 and control, respectively, whereas the grand mean value was recorded as 9.489 cm and 9.839 cm, respectively, as shown in Table: 4. Nasreen *et al.,* (2010) were reported that the leaves are 10-20 cm long and 8-15 cm broad.

CONCLUSION

From the above results and discussions, it can be concluded that the maximum stem diameter (20.67 mm) was recorded from the application of Farm Yard Manure (FYM) at 10 t ha^{-1}, which are highly significant values. Whereas the minimum (16.02 mm) stem diameter was recorded from the control. Farm Yard Manure (FYM) is best for commercial cultivation of Giloy. In Jharkhand, due to the presence of acidic soil, micro and macronutrients are not available to plants; therefore, growth is being affected. The application of organic fertilizers helped to improve soil nutrients and their physical properties.

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