Effect of Organic and Inorganic Source of Nutrients on Yield of Cotton (*Gossypium hirsutum L.*) under Teak (*Tectona grandis*) Based Agroforestry System

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Abstract— *The current investigation was conducted in the Forest Nursery, SHUATS, Prayagraj, U.P., between 2021 and 2022. Based on a field experiment conducted on the effect of Organic and Inorganic Nutrient Sources on Growth and Yield of Cotton (Gossypium hirsutum L.) Under Teak (Tectona Grandis) Based Agroforestry System, it was concluded that the treatment T7 (NPK 100 percent) was found superior among that treatment under teak based Agroforestry system. It was also observed that maximum Cotton Yield (i.e., 24.16t/ha) In terms of economic feasibility performance, treatment T7 (NPK 100 percent) demonstrated the highest benefit-cost ratio (i.e., 1.67).*

Keywords— Cotton, Teak, Growth, Yield, Organic, Inorganic, Agroforestry.

I. INTRODUCTION

Cultivating agricultural crops and trees in tandem is an ancient practise all over the world. Agroforestry refers to long-term land use systems that combine trees with arable crops or animals on the same plot of land in some kind of spatial arrangement or temporal sequence. Agroforestry is recognised as one of the most effective strategies for achieving optimal multiple benefits through an interactive and intentional land use system and technologies in which trees are purposefully planted with agricultural crops or animals. It is a traditional practise in India and has received increased attention in recent years as a high-potential sustainable land use option. The various components of an agroforestry system interact in both ecological and economic ways (**Lundgren and Raintree, 1982**). Agroforestry systems are designed to meet the economic, social, and cultural needs of the local population while maintaining ecological balance. Multipurpose tree species (MPTS) have been introduced into agroforestry systems to increase the economic importance of the tree component. Multipurpose trees and shrubs are those that have more than one preferred use, product, and/or service.

Teak (Tectona grandis) is the most important high-value furniture wood grown in plantations all over the world. Teak is a relatively easy plantation species to establish, and due to the ongoing global demand for teak wood products, it has good economic prospects as a plantation species for fine woods**. Ladrach, William (2009).**

More than 70 nations in tropical and subtropical regions cultivate cotton, a significant fibre crop on a global scale. With a productivity of 493 kg lint/ha in 2011–12, India had the biggest area (121 lakh ha) and the second-highest production (353 lakh bales), only behind China (Anonymous, 2012). In terms of creating direct and indirect jobs in the agricultural and industrial sectors, cotton is significant to the national economy (Shivamurthy D 2012). Cotton exports make up 65% of all textile exports and are responsible for 33% of all foreign exchange earnings for our nation (17 billion dollars). The production of cotton in Indian agriculture has seen a substantial transformation as a result of the introduction of Bt cotton, which is renowned for its resistance to bollworms, into the nation over the past ten years. Since the introduction of Bt cotton, the circumstances for growing cotton have improved in Karnataka. In 2012, 5.54 lakh hectares of cotton were used to produce 15.0 lakh bales of seed cotton at a productivity of 460 kg lint/ha. More than 90% of India's cotton land is now planted with bt cotton. However, when small pests like mealy bugs, shoot weevils, midges, mirid bugs, cotton leaf curl virus, and physiological problems like leaf reddening, squire dropping, squire drying, and so on become a serious danger,

productivity is reducing year after year. As stated by **Hosmath (**2012). Red leaf index (1.82) was substantially higher in Bt cotton genotypes than in non-Bt cotton genotypes (1.63). Lack of nitrogen and magnesium, which results in the synthesis of anthocyanin, is the primary cause of reddening. In this regard, the planning and execution of the present inquiry took place throughout the kharif seasons of 2020 and 2021.

II. MATERIALS AND METHODS

The Present Investigation was Entitled with "Effect of Organic and Inorganic Source of Nutrients on Growth and Yield of Cotton (*Gossypium hirsutum* L.) under Teak (*Tectona grandis*) Based Agroforestry System"in Bhadradri Kothagudem District at Telangana, During *Kharif* Season 2021-22. MATERIALS: Location: The field experimental study was conducted at the Gollagudem Road, Gopathanda village, Sarvaram, Sujathanagar, Bhadradri Kothagudem District at Telangana. Experimental site: The experiment was carried out during *Kharif season* of 2021Sarvaram (Gopatanda) is situated at having the latitude 17.522337^0, longitude 80.585286^0. In direction of East- west and North -West direction. Climate and Weather condition

The temperature in Kothagudem is $26^{\circ c}$ maximum temperature would hover at $32^{\circ c}$, while minimum temperature is predicted to be $26^{\circ c}$.This region has a sub-tropical climate, and having Rainfall of Normal annual rainfall 824.1 mm Annual rainfall 1430.4mmmostly during the monsoon autumn i.e. July- Nov with a few occasional showers during winter months. The major Soils are Red sandy soils sandy loam soils black soils. The major soil types suitable for cotton cultivation are alluvial, clayey and red sandy loam. Cotton is grown both under irrigated and rain fed conditions.

III. RESULTS AND DISCUSSION

The findings of the present experiment entitled, **"Effect of Organic and Inorganic Source of Nutrients on Growth and Yield of Cotton (*Gossypium hirsutum* L.) Under Teak (*Tectona grandis*) Based Agroforestry System",** are being presented and discussed in the following pages under appropriate headings. Data on pre-harvest (pertaining to growth attributes) and post-harvest (relating to yield attributes and economic parameters) observations were statistically analyzed in the light of scientific reasoning and relevant review of literature has been stated.

Plant Height (cm) 30DAS Data presented in table 1 indicated that highest the plant height (cm) at 30 DAS was observed in treatment T_9 15.50cm (NPK 50 % + FYM 25% + 25 NC %) followed by T_8 13.93cm (NPK 75% + FYM 25%), $T_6$12.40cm (NC 50% + FYM 25% + NPK 25%) and T_3 11.20cm (FYM 50% + NC 25% + NPK 25%). The lowest value for the plant height was observed in treatment T_1 6.20 cm FYM 100%. Under teak-based Agroforestry system respectively. The result obtained was found Significant throughout the study.

Plant Height (cm) at 60 DAS Data presented in table 1 indicated that highest the plant height (cm) at 60 DAS was observed in treatment T_9 79.33cm (NPK 50 % + FYM 25% + 25 NC %) followed by T_8 75.03cm (NPK 75% + FYM 25%), T_6 75.03cm (NC 75% +FYM 25%) and T_3 67.40cm (FYM 50% + NC 25% + NPK 25%). The lowest value for the plant height was observed in treatment T_1 31.96 cm FYM 100%. Under teak-based Agroforestry system respectively. The result obtained was found Significant throughout the study.

Plant Height (cm) at 90 DAS: Data presented in table 1 indicated that highest the plant height (cm) at 90 DAS was observed in treatment T_9 106.53 cm (NPK 50 % + FYM 25% + 25 NC %) followed by T_8 98.93 cm (NPK 75% + FYM 25%), T_6 91.83cm (NC 75% +FYM 25%) and T_3 86.73cm (FYM 50% + NC 25% + NPK 25%). The lowest value for the plant height was observed in treatment T_1 75.86 cm FYM 100%. Under teak-based Agroforestry system respectively. The result obtained was found Significant throughout the study.

Plant Height (cm) at 120 DAS: Data presented in table 1 indicated that highest the plant height (cm) at 120 DAS was observed in treatment T_9 123.33cm (NPK 50 % + FYM 25% + 25 NC %) followed by T_8 121.33cm (NPK 75% + FYM 25%), T_6 115.33cm (NC 75% +FYM 25%) and T_3 113.66cm (FYM 50% + NC 25% + NPK 25%). The lowest value for the plant height was observed in treatment T_1 97.66 cm FYM100%. Under teak-based Agroforestry system respectively. The result obtained was found Significant throughout the study.

Leaf index at 30 DAS: Data presented in table 1 indicated that highest the Leaf index at 30 DAS was observed in treatment T_9 0.21 (NPK 50 % + FYM 25% + 25 NC %) followed by T_8 0.19 (NPK 75% + FYM 25%), T_6 0.17(NC 50% + FYM 25% + NPK 25%) and T_3 0.16 (FYM 50% + NC 25% + NPK 25%). The lowest value for the Leaf index was observed in treatment T_1 0.10 FYM 100%. Under teak-based Agroforestry system respectively. The result obtained was found Significant throughout the study.

Leaf index at 60 DAS: Data presented in table 1 indicated that highest the Leaf index at 60 DAS was observed in treatment T_9 0.34 (NPK 50 % + FYM 25% + 25 NC %) followed by T_8 0.33 (NPK 75% + FYM 25%), T_6 0.32 (NC 50% + FYM 25% + NPK 25%) and T_3 0.31 (FYM 50% + NC 25% + NPK 25%). The lowest value for the Leaf index was observed in treatment T_1 0.25 FYM 100%. Under teak-based Agroforestry system respectively. The result obtained was found Significant throughout the study.

Leaf index at 90 DAS : Data presented in table 1 indicated that highest Leaf index at 90 DAS was observed in treatment T_9 0.89 (NPK 50 % + FYM 25% + 25 NC %) followed by T_8 0.88 (NPK 75% + FYM 25%), $T_{6\ 0.86}$ (NC 50% + FYM 25% + NPK 25%) and T_3 0.83 (FYM 50% + NC 25% + NPK 25%). The lowest value for the Leaf index was observed in treatment T_1 0.73 FYM 100%. Under teak-based Agroforestry system respectively. The result obtained was found Significant throughout the study.

Leaf index at 120 DAS: Data presented in table 1 indicated that highest the Leaf index at 120 DAS was observed in treatment T_9 1.21 (NPK 50 % + FYM 25% + 25 NC %) followed by T_8 1.20 (NPK 75% + FYM 25%), T_6 1.17 (NC 50% + FYM 25% + NPK 25%) and T_3 1.16 (FYM 50% + NC 25% + NPK 25%) The lowest value for the Leaf index was observed in treatment T_1 0.10 FYM 100%. Under teak-based Agroforestry system respectively. The result obtained was found Significant throughout the study.

TABLE 1
EFFECT OF ORGANIC AND INORGANIC SOURCE OF NUTRIENTS ON GROWTH OF COTTON (*GOSSYPIUM HIRSUTUM L.*) UNDER TEAK (*TECTONA GRANDIS*), BASED AGROFORESTRY SYSTEM 30, 60, 90 & 120 DAS ON PLANT HEIGHT OF COTTON

	Treatment Combinations	Plant Height (cm)				Leaf area index			
		30DAS	60DAS	90DAS	120DAS	30DAS	60DAS	90DAS	120DAS
T_1	FYM 100%	**6.20**	**31.96**	**75.86**	**97.66**	**0.10**	**0.25**	**0.73**	**0.10**
T_2	FYM 75% + NC 25%	7.06	41.53	78.50	103.00	0.13	0.26	0.73	1.10
T_3	FYM 50% + NC 25% + NPK 25%	11.20	67.40	86.73	113.66	0.16	0.31	0.83	1.16
T_4	NC 100%	9.20	52.76	81.06	107.00	0.13	0.27	0.75	1.13
T_5	Neem Cake 75% + FYM 25%	8.13	47.83	80.20	105.00	0.11	0.26	0.74	1.11
T_6	NC 50% + FYM 25% + NPK 25%	12.40	70.66	91.83	115.33	0.17	0.32	0.86	1.17
T_7	NPK 100%	10.13	58.83	84.13	110.00	0.13	0.29	0.77	1.14
T_8	NPK 75 % + FYM 25%	**13.93**	**75.03**	**98.93**	**121.33**	**0.19**	**0.33**	**0.88**	**1.20**
T_9	NPK 50 % + FYM 25% + 25 NC %	**15.50**	**79.33**	**106.53**	**123.33**	**0.21**	**0.34**	**0.89**	**1.21**
	F test	S	S	S	S	**S**	**S**	**S**	**S**
	C.D. (0.05%)	0.357	2.087	3.114	5.228	0.02	0.01	0.009	0.003
	SE(m)	0.118	0.690	1.030	1.729	0.009	0.003	0.003	0.001
	SE(d)	0.167	0.976	1.457	2.445	0.013	0.005	0.004	0.001
	C.V.	1.966	2.048	2.048	2.705	10.52	1.94	0.63	0.17

***FYM: Farm** Yard Manure, NC: Neemcake, **NPK:** Recommended dose of nitrogen (120-60-60)*

TABLE 2
EFFECT OF ORGANIC AND INORGANIC SOURCE OF NUTRIENTS ON GROWTH OF COTTON (*GOSSYPIUM HIRSUTUM L.*) UNDER TEAK (*TECTONA GRANDIS*), BASED AGROFORESTRY SYSTEM30, 60, 90 & 120 DAS ON PLANT HEIGHT OF COTTON.

Treatment No.	Treatment Combinations	Primary fruiting branch plant	Secondary fruiting branch plant	Number of Sympodial branches (no)	Days of first flowering
T_1	FYM 100%	**12.86**	**4.06**	**14.46**	61.66
T_2	FYM 75% + NC 25%	12.66	5.06	14.60	64.00
T_3	FYM 50% + NC 25% + NPK 25%	13.10	5.43	15.66	65.00
T_4	NC 100%	12.76	5.33	14.90	63.33
T_5	Neem Cake 75% + FYM 25%	12.60	5.26	14.66	63.66
T_6	NC 50% + FYM 25% + NPK 25%	13.14	5.50	15.73	69.86
T_7	NPK 100%	12.96	5.46	15.36	64.66
T_8	NPK 75 % + FYM 25%	**13.40**	**5.73**	**15.93**	**70.33**
T_9	NPK 50 % + FYM 25% + 25 NC %	**14.10**	**5.93**	**16.06**	**70.66**
	F test	S	S	**S**	NS
	C.D. (0.05%)	0.732	0.33	0.62	-
	SE(m)	0.242	0.10	0.20	2.53
	SE(d)	0.342	0.154	0.29	3.58
	C.V.	3.209	3.557	2.32	70.66

3.1 Primary fruiting branch plant

Data presented in table 2 indicated that Primary fruiting branch plant was observed in treatment T_9 14.10 (NPK 50 % + FYM 25% + 25 NC %) followed by T_8 13.40 (NC 75% + FYM 25%), T_6 13.14 (NPK 50% + FYM 25% + NPK 25%) and T_3 13.10 (FYM 50% + NC 25% + NPK 25%). The lowest value for the Primary fruiting branch plant was observed in treatment T_1 12.86 FYM 100%. Under teak-based Agroforestry system respectively. The result obtained was found Significant throughout the study.

3.2 Secondary fruiting branch plant

Data presented in table 2 indicated that Secondary fruiting branch plant was observed in treatment T_9 5.93 (NPK 50 % + FYM 25% + 25 NC %) followed by T_8 5.733 (NPK 75% + FYM 25%), T_6 5.50 (NC 50% + FYM 25% + NPK 25%) and T_3 5.43 (FYM 50% + NC 25% + NPK 25%). The lowest value for the Secondary fruiting branch plant was observed in treatment T_1 4.06 NPK 100%. Under teak-based Agroforestry system respectively. The result obtained was found Significant throughout the study.

3.3 Number of Sympodial branches (no)

Data presented in table 3 indicated that Number of Sympodial branches (no) was observed in treatment T_9 16.06 (NPK 50 % + FYM 25% + 25 NC %) followed by T_8 15.93 (NPK 75% + FYM 25%), T_6 15.73 (NC 50% + FYM 25% + NPK 25%) and T_3 15.66 (FYM 50% + NC 25% + NPK 25%). The lowest value for the Number of Sympodial branches (no) was observed in treatment T_1 14.46 FYM 100%. Under teak based Agroforestry system respectively. The result obtained was found Significant throughout the study.

3.4 Day of first flowering per days (no)

Data presented in table 2 indicated that Day of first flowering per days (no)was observed in treatment T_9 63.33(NPK 50 % + FYM 25% + 25 NC %) followed by T_8 61.66 (NPK 75% + FYM 25%), T_6 64.66 (NC 50% + FYM 25% + NPK 25%) and T_3

64.00 (FYM 50% + NC 25% + NPK 25%). The lowest value for the Day of first flowering per days (no) was observed in treatment T_1 70.66 FYM100%. Under teak based Agroforestry system respectively. The result obtained was found Significant throughout the study.

3.5 Number of bolls plant (no)

Data presented in table no 3 indicated that highest number of bolls plant (no) was observed in treatment T_9 90.66(NPK 50 % + FYM 25% + 25 NC %) followed by T_8 90.00 (NPK 75% + FYM 25%), T_6 86.66 (NC 50% + FYM 25% + NPK 25%) and T_3 84.33 (FYM 50% + NC 25% + NPK 25%) The lowest value for the Number of bolls plant was observed in treatment T_1 77.66 FYM 100%. Under teak-based Agroforestry system respectively. The result obtained was found Significant throughout the study. **Bolls per m^{-2}** Data presented in table 3 indicated that highest Bolls per m-2 was observed in treatment $T_9$148.66 (NPK 50 % + FYM 25% + 25 NC %) followed by T_8 126.00 (NPK 75% + FYM 25%), T_6 112.53 (NC 50% + FYM 25% + NPK 25%) and $T_3$103.33 (FYM 50% + NC 25% + NPK 25%). The lowest value for Bolls per m-2was observed in treatment T_1 70.66 FYM 100%. Under teak based Agroforestry system respectively. The result obtained was found Significant throughout the study.

TABLE 3
EFFECT OF ORGANIC AND INORGANIC SOURCE OF NUTRIENTS ON GROWTH AND YIELD OF COTTON (GOSSYPIUM HIRSUTUM L.) UNDER TEAK (TECTONA GRANDIS) BASED AGROFORESTRY SYSTEM NUMBER OF BOLLS PLANT AND BOLLS PER M-2 OF COTTON.

	Treatment Combinations	Number of bolls plant	Bolls per m^{-2}	Single boll weight(g)	Cotton yield quintal / ha
T_1	FYM 100%	**77.66**	**70.66**	**4.03**	**17.00**
T_2	FYM 75% + NC 25%	71.00	80.13	4.06	17.04
T_3	FYM 50% + NC 25% + NPK 25%	84.33	103.33	5.26	23.48
T_4	NC 100%	76.66	88.93	4.53	21.01
T_5	Neem Cake 75% + FYM 25%	76.33	85.06	4.27	17.35
T_6	NC 50% + FYM 25% + NPK 25%	86.66	112.53	5.53	23.49
T_7	NPK 100%	80.66	96.40	5.00	23.04
T_8	NPK 75 % + FYM 25%	**90.00**	**126.00**	**5.78**	**23.74**
T_9	NPK 50 % + FYM 25% + 25 NC %	**90.66**	**148.66**	**5.90**	**24.16**
	F test	S	S	S	S
	C.D. (0.05%)	7.28	3.79	0.79	2.17
	SE(m)	2.40	1.25	0.26	0.71
	SE(d)	3.40	1.77	0.37	1.01
	C.V.	5.11	2.14	9.18	5.88

3.6 Single boll weight (g)

Data presented in table 3 indicated that highest Single boll weight (g) was observed in treatment T_9 5.90 (NPK 50 % + FYM 25% + 25 NC %) followed by T_8 5.78 (NPK 75% + FYM 25%), T_6 5.53 (NC 50% + FYM 25% + NPK 25%) and T_3 5.26 (FYM 50% + NC 25% + NPK 25%). The lowest value for Single boll weight (g) was observed in treatment T_1 4.03 FYM 100%. Under teak based Agroforestry system respectively. The result obtained was found Significant throughout the study. **Cotton yield quintal/ ha:** Data presented in table 3 indicated that highest Cotton yield quintal/ ha was observed in treatment T_9 24.16 (NPK 50 % + FYM 25% + 25 NC %) followed by T_8 23.74 (NPK 75% + FYM 25%), T_6 23.49 (NC 50% + FYM 25% + NPK 25%) and T_3 23.48 (FYM 50% + NC 25% + NPK 25%). The lowest value for Cotton yield quintal / ha was observed in treatment T_1 17.00 FYM 100%. Under teak-based Agroforestry system respectively. The result obtained was found Significant throughout the study.

IV. DISCUSSION

M Jayakumar 2017 also reported a comparable outcome. The cotton plant height under the teak-based agroforestry model was 138.01 cm, which is significantly higher than the plant height 123.33 at 120DAS. **M Jayakumar 2014** also noted a comparable outcome. When compared to the largest number of sympodial branches, which was 16.06 at the time of growth, cotton grown under a teak-based agroforestry model had 18.08 fewer sympodial branches. **Islamm.K 2014**. also reported a similar outcome. Primary fruiting branches 14.04 are much fewer than primary fruiting branches 14.10, which were the highest at the time of growth in cotton under the teak-based agroforestry model. **Islamm.K 2014**. also reported a similar outcome. When compared to the highest Days of First Flowering per Day of 14.10 during the period of growth, Cotton under a teak-based agroforestry model has significantly fewer Days of First Flowering per Day of 14.04 than those. **Islamm.K 2014**. also reported a similar outcome. When compared to bolls fruiting branches, which were at their maximum at the period of growth (63.33), the number of fruiting per branch bolls for cotton under the teak-based agroforestry model was 68.10. **Das Anup 2010** also reported a comparable outcome. LAI 3.83 is much lower than LAI 1.210, which was the greatest during the period of growth for cotton under the teak-based agroforestry model. A similar result was also reported by **M Jayakumar 2014.** No of Bolls per plant 73.44. no as compere to No of Bolls per plant 90.66 highest at growth time, Cotton under teak-based agroforestry model that No of Bolls per plant significantly. **M Jayakumar 2014** also noted a comparable outcome. When compared to the highest single boll weight (g) of 5.90 g during growth time, cotton under a teak-based agroforestry model slightly outweighed single bolls at 4.94 g. **Manchalas.k. 2017** also reported a comparable outcome. Cotton under teak-based agroforestry model that single Cotton yield q/ h considerably, cotton yield 19.00 q/ h no as compare to single cotton yield 24.16 q/ h highest at growing time.

V. CONCLUSION

On the basis of field experiment conducted on "Effect of Organic and Inorganic Source of Nutrients on Growth and Yield of Cotton (*Gossypium hirsutum L.*) Under Teak (*Tectona grandis*) Based Agroforestry System" concluded that the treatment T_9 (NPK 100%) was found superior among that treatment under teak-based Agroforestry system it was also observed that maximum Cotton Yield (**24.16t ha-^{1}**)

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