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Effect of Manures on Growth and Yield and Yield Attributes of Rice under Drumstic *(Moringa oleifera* L.*)* based Agroforestry System

R Vijaykumar[1*] and Neelam Khare[2]

College of Forestry, Sam Higginbottom University of Agriculture, Technology & Sciences Prayagraj, U.P
***Corresponding E. mail: vijaykumarrathod7@gmail.com**

Abstract

A field experiment was conducted at Forest Nursery and research Centre (College of Forestry) of Sam Higginbottom University of Agriculture, Technology & Sciences Prayagraj during kharif season 2018-19 with sixteen treatments replicated thrice in a randomized block design to efficiency of different Manures on the growth and yield of Rice under Drumstic (*Moringa oleifera*) based agroforestry system. Along with discussion on the experiment finding in the light of scientific reasons to understand the cause and effect relationship dully supported by finding. The data regarding growth, yield attributes, yield, economics, soil physic-chemical parameter and Biometric observation of Tree crop were recorded at suitable crop growth stage, respectively were the manures in the experimental field. Among the organic manure, green manure, green leaf manure with control treatments, result shows that significantly, The maximum performance of Grain yield observed inT_6 (41.31 q ha-1) (50% Goat manure + 50% *Crotalaria juncea*) followed by T_{10} (41.21 q ha-1) (50% Goat manure + 50% *Pongamia glabra*) respectively and minimum Grain yield recorded in T0 (37.61 q ha-1) (control). The maximum performance of straw yield observed inT_6 (23.43 q ha-1) (50% Goat manure + 50% *Crotalaria juncea*) and minimum straw yield recorded in T_0 (22.90 q ha-1) (control). The maximum performance of biological yield observed inT_6 (64.75 q ha-1 and minimum biological yield recorded in T_0 (60.51 q ha-1) (control). The maximum performance of harvest Index observed inT_6 (63.78%) (50% Goat manure + 50% *Crotalaria juncea*) and minimum harvest Index recorded in T_0 (62.15%) (Control) under *Moringa oleifera* based agroforestry system.

Keywords: Rice, Organic Manures, Green Manures, Green leaf manures Manure *Moringa oleifera* L.

Introduction

Agroforestry is the focus of a subtle difference in durability and intensification between the conventional agroforestry method (TAFS) and conventional agroforestry. Traditionally, agroforestry systems can be defined as a collection of agroforestry systems that have been practiced around the global with varying frameworks (Tanzi 2013) work socioeconomic attributes and environmental services, generally without deliberate intensification of the cultivation of agricultural crops or of forage plants. They are mainly found in tropical, subtropical and even temperate regions around the world on the islands of Asia, Africa, Europe, North America, South America and the Pacific, although they are not yet scientifically studied (Karki 2018) The combinations of tree cultivation with agricultural crops worldwide have been enormous. For example, in Europe, abandoned forests were entirely decreased, and agricultural plants were burned and cultivated (Aasif 2019) Silvopastoral systems are complex ecosystems in which wood production and the production of pasture (short-term economic return) are combined. Silvopastoral systems have the same effect. Interactions between three components are characterized: trees, pastures and livestock, which present difficulties for management (Abraham 2016). In the early stages of the growth of silvopastoral systems by (Selvi 2005**)** afforestation there is strong competition between trees and pasture for water and nutrients. Moringa tree also contains antioxidants, anti-inflammatory, phytochemical, omega-3 and omega-6. It has been reported to be capable of reducing nutritional deficiency of children in India or

of feeding people with HIV. The socio-economic interest in the tropics has been very strong. In this region, where hunger constantly takes place, it is important to value their production. *M. oleifera* needs basically fewer fertilizers (Talathi 2009**)** but a normal amount could boost its growth, mainly organic fertilizers for long-term fertilization. The addition of organic matter has proven to enhance soil properties including aggregation, water preservation, hydraulic conductivity, mass density, compaction ratios, fertility and water and wind erosion resistance. For more than half of the world's population, rice is one of the most important staple foods. It is common among people all over the world, regardless of ethnicity, religion or policy. Rice is produced by rain in the central dry zone of Myanmar (Pramanik 2004**)** but is grown in areas where irrigation is possible as an irrigated crop. The dry areas of the country are marked by gravel, sandy loam and sandy soils (Setiawati 2018). Green dung may minimize the exposure of soils to erosive processes, facilitate increased cycling of nutrients, and improve the synchrony between the release of nutrients and crop requests. The potential advantage of green manures as a food source can only be accomplished when the patterns of decomposition and release of nutrients are understood so that the simultaneous release of nutrients can increase with the demand of crops for nutrients.

Materials and Methods

The present investigation was conducted at Forest Nursery and research Centre (College of Forestry) of Sam Higginbottom University of Agriculture, Technology & Sciences Prayagraj during 2018-19 and 2019-2020 under Treatment Combinations T_0 Control (No Manures No Fertilizers), T_1 50% FYM + 50% Sun hemp (*Crotalaria juncea*), T_2 50% FYM + 50% Dhaincha (*Sesbania aculeata*), T_3 50% FYM + 50% Neem (*Azadirachta indica*), T_4 50% FYM + 50% Gulmohar (*Delonix regia)*, T_5 50% FYM + 50% Pongania (*Pongamia glabra*), T_6 50% Goat manure + 50% Sun hemp (*Crotalaria juncea*), T_7 50% Goat manure + 50% Dhaincha (*Sesbania aculeata*), T_8 50% Goat manure + 50% Neem (*Azadirachta indica*), T_9 50% Goat manure + 50% Gulmohar (*Delonix regia)*, T_{10} 50% Goat manure + 50% Pongania (*Pongamia glabra*), T_{11} 50% Poultry manure + 50% Sun hemp (*Crotalaria juncea*), T_{12} 50% Poultry manure + 50% Dhaincha (*Sesbania aculeata*), T_{13} 50% Poultry manure + 50% Neem (*Azadirachta indica)*, T_{14} 50% Poultry manure + 50% Gulmohar (*Delonix regia)*,T_{15} 50% Poultry manure + 50% Pongania (*Pongamia glabra*). The requisite agronomic and plant protection measures were adopted uniformly for all the treatments during the entire growing period. At maturity, data on plant characters and yield components were recorded from five randomly selected plants in each plot. The growth and yield characters were recorded such as plant height at harvest (cm), number of total tillers plant-1, No of effective tillers per hill^{-}, spike length (cm), Length of panicle (cm), Number of panicle per hill^{-1}, number of grains per hill^{-}1, 1000-seed weight (g), grain yield (t ha^{-1}), straw yield (t ha^{-1}), biological yield (q ha^{-1}) and harvest index(%). The crop from each unit plot was harvested at full maturity to record the data on grain and straw yields. Soil physic-chemical parameter. Soil characteristics Initial soil status of the experimental field during 2018. The physico-chemical properties of experimental field are presented in Soil depth (0-15 cm). The Soil pH 6.91 (1:2 soil: water), Electrical conductivity – 0.25 dS m-1, Organic carbon -0.31 (%), Available nitrogen - 151.52 kg ha-^{1}, Available phosphorus 14.80 kg ha-1, Available potassium 240.03 kg ha-^{1}. Biometric observation of tree crop-tree height (m), Diameter at breast height (m), Number of pod per Tree (Kg), Pod Length (cm), Number of seeds per pod (no), 100 seeds weight (g), Pod Yield per tree (Kg), Pod Yield per hectare (q), Net Returns Rs per hectare. The data was analyzed statistically.

Results and discussion

The present investigation entitled "Efficiency of Manures on the Growth and Yield of Rice under Drumstick (*Moringa oleifera*) based Agroforestry System*"* was carried out during one successive year *i.e.* 2019 conducted at Forest Nursery and research Centre, Department of Silviculture and Agroforestry, College of Forestry Sam Higginbottom University of Agriculture, Technology & Sciences Prayagraj. The finding have been presented in this chapter along with discussion on the experiment finding in the light of scientific reasons to understand the cause and effect relationship dully supported by finding of the previous researchers. The data regarding growth, yield attributes, yield, economics, soil physic-chemical parameter and biometric observation of Tree crop were recorded at suitable crop growth stage. The data were subjected to statistical analysis for the convenience of drawing valid conclusion. Some characters are also illustrated with help of graphs wherever felt essential to clarify the results the maximum plant height was showed in T_5 (102.37 cm) (50% FYM + 50% *Pongamia glabra*) followed by T_9 (102.14 cm) T_7 (101.61 cm) and T_6 (101.07 cm)

respectively. Minimum plant height recorded in T_0 (93.94 cm) (control) under *Moringa oleifera* based agroforestry system. Plant height was significant. The maximum number of tillers was showed in T_6 (69.27) (50% Goat manure + 50% *Crotalaria juncea*) followed by T_{10} (68.87) (50% Goat manure + 50% *Pongamia glabra*), T_8 (68.87) and T_7 (6840) respectively. Minimum Number of Tillers recorded in T_0 (61.33) (control) under *Moringa oleifera* based agroforestry system. Number of Tillers was significant. The maximum leaf length (cm) was showed in T_6 (61.85cm) (50% Goat manure + 50% *Crotalaria juncea*) followed by T_{10} (61.65cm) (50% Goat manure + 50% *Pongamia glabra*), T_8 (61.45cm) and T_7 (60.65cm) respectively. Minimum Leaf Length (cm) recorded in T_0 (55.25cm) (control) under *Moringa oleifera* based agroforestry system. The maximum Leaf Area Index was showed in T_6 (10.47) (50% Goat manure + 50% *Crotalaria juncea*) followed by T_{10} (10.42) (50% Goat manure + 50% *Pongamia glabra*), T_8 (10.13) and T_7 (10.00) respectively. Minimum Leaf Area Index recorded in T_0 (9.00) (control) under *Moringa oleifera* based agroforestry system.

The maximum performance of Plant fresh weight was observed inT_6 (205.67 g hill^{-1}) (50% Goat manure + 50% *Crotalaria juncea*) followed by T_{10} (205.00 g hill^{-1}) (50% Goat manure + 50% *Pongamia glabra*) T_8 (204.00 g hill^{-1}) and T_7 (203.67 g hill^{-1}) respectively and minimum Plant fresh weight recorded in T_0 (183.17 g hill^{-1}) (control) under *Moringa oleifera* based agroforestry system. The maximum performance of Plant dry weight was observed inT_6 (122.50 g hill^{-1}) (50% Goat manure + 50% *Crotalaria juncea*) followed by T_{10} (121.83 g hill^{-1}) (50% Goat manure + 50% *Pongamia glabra*) T_8 (120.83 g hill^{-1}) and T_7 (119.17 g hill^{-1}) respectively and minimum Plant dry weight recorded in T_0 (103.00 g hill^{-1}) (control) under *Moringa oleifera* based agroforestry system.

The maximum performance of Number of panicle was observed inT_6 (57.27 cm) (50% Goat manure + 50% *Crotalaria juncea*) followed by T_{10} (56.73 cm) (50% Goat manure + 50% *Pongamia glabra*) T_8 (56.53 cm) and T_7 (56.33cm) respectively and minimum Number of panicle recorded in T_0 (45.53 cm) (control) under *Moringa oleifera* based agroforestry system. The maximum performance of Number of Effective tillers per hill^{-1} was observed inT_6 (6.73 per hill^{-1}) (50% Goat manure + 50% *Crotalaria juncea*) followed by T_{10} (7.23 per hill^{-1}) (50% goat manure + 50% *Pongamia glabra*) T_8 (8.23 per hill^{-1}) and T_7 (8.23 per hill^{-1}) respectively and minimum number of effective tillers per hill^{-1} recorded in T_0 (11.73 per hill^{-1}) (control) under *Moringa oleifera* based agroforestry system. The maximum performance of number of grains per hill^{-1} was observed inT_6 (1146.00 per hill^{-1}) (50% goat manure + 50% *Crotalaria juncea*) followed by T_{10} (1128.33 per hill^{-1}) (50% Goat manure + 50% *Pongamia glabra*) T_8 (1102.83 per hill^{-1}) and T_7 (1088.83 per hill^{-1}) respectively and minimum number of grains per hill^{-1} recorded in T_0 (866.33 per hill^{-1}) (control) under *Moringa oleifera* based agroforestry system. The maximum performance of test weight (g) was observed inT_6 (35.88g) (50% goat manure + 50% *Crotalaria juncea*) followed by T_{10} (35.71g) (50% goat manure + 50% *Pongamia glabra*) T_8 (35.64g) and T_7 (35.51g) respectively and minimum test weight (g) recorded in T_0 (31.32g) (control) under *Moringa oleifera* based agroforestry system.

The maximum performance of Grain yield observed inT_6 (41.31 q ha^{-1}) (50% Goat manure + 50% *Crotalaria juncea*) followed by T_{10} (41.21 q ha^{-1}) (50% Goat manure + 50% *Pongamia glabra*) T_8 (40.98 q ha^{-1}and T_7 (40.85 q ha^{-1}) respectively and minimum Grain yield recorded in T_0 (37.61 q ha^{-1}) (control) under *Moringa oleifera* based agroforestry system. The maximum performance of straw yield observed inT_6 (23.43 q ha^{-1}) (50% Goat manure + 50% *Crotalaria juncea*) followed by T_{10} (23.43 q ha^{-1}) (50% Goat manure + 50% *Pongamia glabra*) T_8 (23.33 q ha^{-1}and T_7 (23.3. q ha^{-1}) respectively and minimum straw yield recorded in T_0 (22.90 q ha^{-1}) (control) under *Moringa oleifera* based agroforestry system. The maximum performance of biological yield observed inT_6 (64.75 q ha^{-1}) (50% Goat manure + 50% *Crotalaria juncea*) followed by T_{10} (64.65 q ha^{-1}) (50% Goat manure + 50% *Pongamia glabra*) T_8 (64.31 q ha^{-1}and T_7 (64.15 q ha^{-1}) respectively and minimum biological yield recorded in T_0 (60.51 q ha^{-1}) (control) under *Moringa oleifera* based agroforestry system. The maximum performance of harvest Index observed inT_6 (63.78%) (50% Goat manure + 50% *Crotalaria juncea*) followed by T_{10} (63.74%) (50% Goat manure + 50% *Pongamia glabra*) T_8 (63.70%) and T_7 (63.66 %) respectively and minimum harvest Index recorded in T_0 (62.15%) (Control) under *Moringa oleifera* based agroforestry system.

Table1. Efficiency of organic manures on growth attributes at the different treatments of Rice under *Moringa oleifera* based agroforestry system

Rice under *Moringa oleifera* based agroforestry system						
Treatment	**Plant height (cm)**	**Number of Tillers**	**Leaf Length (cm)**	**LAI**	**Plant fresh weight (g hill^{-1})**	**Plant dry weight (g hill^{-1})**
T_0	93.08	63.60	57.41	8.79	177.33	101.67
T_1	95.35	62.27	56.41	8.68	175.67	100.00
T_2	95.68	62.33	56.81	8.75	176.00	100.33
T_3	95.02	62.07	56.41	8.66	174.33	99.33
T_4	96.22	62.73	57.21	8.72	177.00	101.33
T_5	101.52	68.40	61.16	9.80	194.33	117.00
T_6	100.22	67.53	59.96	9.33	192.33	113.67
T_7	100.75	68.00	60.76	9.46	192.67	115.33
T_8	100.02	67.00	59.76	9.11	191.00	113.33
T_9	101.28	68.00	60.96	9.74	193.67	116.33
T_{10}	97.68	66.00	58.43	9.08	185.67	109.33
T_{11}	96.62	65.00	57.43	8.91	183.33	106.00
T_{12}	96.88	65.53	57.83	9.01	183.33	107.00
T_{13}	96.62	64.87	57.16	8.86	183.00	105.67
T_{14}	97.15	65.87	58.23	9.01	184.33	108.67
T_{15}	96.46	60.47	54.56	8.29	171.33	96.67
F-test	**S**	**S**	**S**	**S**	**NS**	**S**
C.D. (P=0.005)	2.216	0.406	1.383	0.106	-	7.090
SE(m)	0.764	0.140	0.476	0.036	6.175	2.443
SE(d)	1.080	0.198	0.674	0.052	8.732	3.455
C.V.	1.356	0.373	1.419	0.701	5.829	3.956

Table2. Efficiency of organic manures on growth attributes at the different treatments of Rice under *Moringa oleifera* based agroforestry system

	Rice under *Moringa oleifera* based agroforestry system				
Treatment	**Length of panicle (cm)**	**Number of panicle per hill^{-1}**	**No of effective tillers per hill^{-}**	**Number of grains per hill^{-1}**	**Test weight (g)**
T_0	23.43	48.07	10.53	914.33	32.60
T_1	23.07	46.33	11.30	894.67	32.36
T_2	23.10	46.50	11.30	902.33	32.48
T_3	23.07	46.23	11.47	878.00	31.91
T_4	23.37	47.90	11.07	906.00	32.56
T_5	27.30	51.27	7.63	1076.67	35.18
T_6	25.90	50.33	9.13	1036.67	34.94
T_7	26.33	50.53	9.13	1041.67	34.81
T_8	25.77	49.87	9.47	1016.33	34.73
T_9	27.00	50.73	8.13	1070.00	35.01
T_{10}	24.87	45.57	9.87	1011.67	33.97
T_{11}	24.40	43.60	10.20	977.33	33.12
T_{12}	24.60	43.67	10.07	972.00	33.24
T_{13}	23.97	43.40	10.13	933.67	32.70

T_{14}	24.63	44.20	9.90	980.00	33.43
T_{15}	21.43	39.53	12.63	786.67	30.62
F-test	**S**	**S**	**S**	**S**	**S**
C.D. (P=0.005)	1.272	2.338	1.748	71.601	0.927
SE(m)	0.438	0.806	0.602	24.671	0.319
SE(d)	0.620	1.140	0.852	34.891	0.451
C.V.	3.096	2.986	10.308	4.440	1.658

Table 3. Efficiency of organic manures on yield attributes at the different treatments of rice under *Moringa oleifera* based agroforestry system

	Rice under *Moringa oleifera* based agroforestry system			
Treatment	**Grain yield (q ha^{-1})**	**Straw yield (q ha^{-1})**	**Biological yield (q ha^{-1})**	**Harvest Index (%)**
T_0	37.86.67	22.80.00	60.66.67	64.40
T_1	37.23.33	22.73.33	59.96.67	64.09
T_2	37.60.00	22.76.67	60.36.67	64.12
T_3	37.10.00	22.70.00	59.80.00	64.07
T_4	37.73.33	22.80.00	60.53.33	64.30
T_5	39.96.67	23.43.33	63.40.00	**64.55**
T_6	39.50.00	23.30.00	62.80.00	64.43
T_7	39.63.33	23.33.33	62.96.67	64.47
T_8	39.43.33	23.26.67	62.70.00	64.42
T_9	39.86.67	23.43.33	63.30.00	64.49
T_{10}	39.26.67	23.20.00	62.46.67	64.02
T_{11}	38.46.67	23.06.67	61.53.33	63.74
T_{12}	38.70.00	23.16.67	61.86.67	63.90
T_{13}	38.36.67	23.03.33	61.40.00	63.68
T_{14}	39.03.33	23.16.67	62.20.00	63.95
T_{15}	36.26.67	22.90.00	59.16.67	62.99
F-test	**S**	**NS**	**S**	**NS**
C.D. (P=0.005)	109.766	--	135.770	-
SE(m)	37.822	33.734	46.782	0.428
SE(d)	53.488	47.707	66.160	0.606
C.V.	1.701	2.533	1.316	1.157

Table 4: Morphological attributes of Tree Growth development and yield of *Moringa oleifera* 2019-2020

Tree no.	Tree Height (m)	Diameter at Breast Height (DBH)	Number of pod per Tree	Pod Length (cm)	Number of seeds per pod (no)	100 seeds weight (g)	Pod Yield per tree (Kg)	Pod Yield per hectare (q)	Net Returns Rs per hectare
P_1	13.55	0.47	1037	31.33	21.33	22.17	5.38	19.92	54.636
P_2	12.30	0.49	1100	31.67	20.84	22.67	5.35	19.80	54.482
P_3	12.00	0.48	1040	31.17	21.67	23.17	5.35	19.80	54.390
P_4	12.25	0.45	1034	30.84	21.00	22.50	5.23	19.37	53.187
P_5	13.90	0.42	1024	32.34	21.50	22.17	5.42	20.04	55.130
P_6	14.80	0.48	1017	31.17	22.00	22.67	5.20	19.24	52.941
P_7	13.95	0.47	978	31.67	21.00	21.84	5.35	19.80	54.482
P_8	13.90	0.48	1028	31.84	21.50	22.17	5.25	19.43	53.341
P_9	13.65	0.50	1017	31.84	21.00	22.17	5.35	19.80	54.513
P_{10}	13.60	0.45	1020	30.67	21.50	22.33	5.18	19.18	52.694
F test	Total	Total	NS	NS	NS	NS	NS	NS	NS
C C.D	133.90	4.65	-	-	-	-	-	-	-
SE(m)	Mean	Mean	57.00	0.65	0.73	0.61	0.13	46.37	1296.65
SE(d)	13.39	0.47	80.61	0.92	1.03	0.86	1.28	39.99	1165.68
C.V.			9.59	3.58	5.95	4.71	2.43	2.43	2.43

Morphological attributes of Tree growth:

Growth, development and yield

It is a fast-growing, deciduous tree that cans *M. oleifera* grows rapidly on favorable sites, with height increments of 1 to 3 m per year during the first 5 to 6 years. It is not known how long trees normally live. In an experiment conducted under rain fed conditions in Prayagraj, planted tree under agroforestry system. Attained an average height of 4.1 m during the first year. While trees rarely grow taller than 10 to 16 m, they occasionally attain heights of up to 14.80 m followed by 13.95 with stem diameters of up to 50 cm. pod production begins as early as 6 to 8 months after planting in the case of trees raised from stem and branch cuttings. Fruit yields are generally during the 2 years, a single tree can yield per tree between 5.42 kg followed by 5.38 kg pod yield per each year, I calculated per hectare yield 20.04 q/ ha followed by 19.92 q/ ha, Net returns per year 55.130 Rs/ha followed by 54.636 Rs/ ha.

Conclusion

Results of above experiment concluded that, the integration of N-levels with organic manures and green manures which lead to promising approach with regard to agriculture aspects where, the farmer an affordable point of view, starting from examining inherent yield, economics and soil health quality up to fetching maximum production, productivity and profitability with higher economic returns in fulfilling needs of hungry farmers. Results accumulated from this investigation, it was concluded that the organic manure *i.e.*, among 3 different combinations of Cow

Manure, Sheep Manure, Poultry manure and 5 green manures and green manures, *i.e.* Sunhemp *Crotalaria juncea*, Dhaincha *Sesbania aculeate*, Pongania *Pongamia glabra*, Neem *Azadirachta indica*, Gulmohar *Delonix regia*, respectively. Therefore, under Drumstick (*Moringa oleifera* L.) both growth, yield attributes, yield have been found to be maximal in T_6-50% Goat manure + 50% (*Crotalaria juncea*) so it is suggested that organic manure to be provided with green manure for achieving high yield. Organic manure application also offers the positive soil health effect it enhances soil structure and texture consistency. This reduces the bulk density and as a result, the potential for water preservation rises as the volume of available nitrogen increases. This helps plant growth development and even improve yield. Manures use is highly suitable for rice in both under Drumstick (*Moringa oleifera* L.), is very effective and less expensive than organic manures.

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