Journal of AgriSearch, 11 (1): 05-08
An Open Access International Peer Reviewed Quarterly

ISSN : 2348-8808 (Print), 2348-8867 (Online)
https://doi.org/10.21921/jas.v11i01.14765

Pearl Millet Performance Affected by Tree Leaf Mulch Under Custard Apple Based Agri-horti System

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ABSTRACT

Field experiment was carried out to evaluate the effect of different tree leaf mulch and quantity of leaf mulch on growth and yield of pearl millet in custard apple based agri-hort system. In this experiment pearl millet imposed in factorial randomized block design having three different levels of leaf mulching 0, 2 and 4 t ha^{-1} and three type of leaf mulch *Azadirachta indica, Eucalyptus species* and *Leucaena leucocephala*. The treatments were replicated thrice. Result of the experiment revealed that growth attributes of pearl millet viz. plant height, number of leaf plant^{-1}, number of tiller plant^{-1} observed no significant variation due to type of mulch. Plant height and dry matter accumulation plant^{-1} had significant variation under quantity of mulches. The growth attributes had higher values with 4 t ha^{-1} mulchas compared to 0 t/ha^{-1} mulch (no mulching). The highest grain yield (1657 kg ha^{-1}) was obtained with *Leucaena leucocephala* leaf mulch and with the application of 4 t ha^{-1} mulch (1735 kg ha^{-1}).

Keywords: Agri-horti system, Leaf mulch, Pearl millet

ARTICLE INFO

Received on	:	14.02.2024
Accepted on	:	23.03.2024
Published online	:	31.03.2024

INTRODUCTION

Agroforestry is a technique of intensive land management that aims to maximize the advantages of the biological interactions that result from the selective pairing of trees and/or shrubs with crops and/or livestock (Sharma *et al.*,2017). Agroforestry has the potential to create a more integrated, diverse, productive, profitable, healthy, and sustainable land-use system. However, it is essentially required that before introduction of any crop in between the alleys of agri-horti system it is utmost important to work out the compatibility of component species (annual crop and perennial tree), because many a time, due to negative interactions between the component species, the growth and yield of annual crop was seriously affected (Thapaliyal *et al.*, 2008).

Therefore, one of the ways for increasing the production is the utilization of inter-row spaces under the agroforestry system for the introduction of annual crops. Among the various categories of agroforestry system, agri-horti system is most popular among the farmers, where the annual crops are grown simultaneously in the alley of the fruit-tree (Lundgren and Raintree, 1982). This system not only helps in better utilization of land resources but also generates more employments and income as compared to sole cultivation of fruit trees. Actually, during the initial 6-7 years of agri-horti systems and even after that period, with proper pruning management, intercrop annual crops in agri-horti systems produce good yield, without any significant reduction (Kumar, 2018).

Agri-horti system is one among various land use systems, which is most important in terms of economic returns to the farmers. In various agroforestry systems evaluated agri- horti system is found to be most profitable. In agri-horti systems, the selection of crop is most important. A careful selection of intercrop can reduce the mutual competition of resources to a considerable extent and may provide additional income to the farmers. The nature of interaction between two components can be described on the basis of observable net effect of one component on another in a system. The tree and crop component help each other, by creating favorable condition for their growth in such a way that the agri-horti systems provides an efficient land use and better economic return than the corresponding sole crop during early phase of orchard establishment, and the interaction between the component is complementary in nature and advantageous under rainfed condition. The farmers grow the fruit crops as a sole crop and the interspaces are left unused. Suitable crop combinations in the interspace of orchard during initial years can generate extra income, enhance productivity, ameliorate and improve ecological situation (Awasthi *et al.*, 2008) in a sustainable manner.

Soil moisture is the most limiting factor in dryland

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agriculture. Mulching has been proved quite effective to conserve the moisture and suppress the weed growth. The erratic nature of monsoon season rainfall has great impact on growth and yield of crops grown in dryland areas during *Kharif* season. A successful crop in such areas is totally depending on an efficient use of soil and water conservation practices. Leaf mulching affects soil water through run-off control, increased infiltration, decreased evaporation and weed control. They affect soil temperature through radiation shielding, heat conduction and trapping, and evaporative cooling. Leaf mulching improves soil nutrients status through organic matter addition, differential nitrification, mineral solubility, improves soil structure and affects soil biological regime through organic matter buildup, microbial and soil fauna populations. They also affect soil salinity through leaching, reduce evaporation and reducing subsequent return of the salts to the leaching zones.

MATERIALS AND METHODS

The experiment was carried out at the Agricultural Research Farm, Rajiv Gandhi South Campus, Banaras Hindu University, Barkachha, Mirzapur (UP) which is situated in *Vindhyan* region of district Mirzapur. Geographically, experimental site falls under the sub-tropical zone and located on 25^{0}10' N latitude 82^0 37' E longitudes and an altitude of 147 meters above mean sea level. The field experiment was conducted during *kharif* season of 2013-14 in seven-year-old custard apple which was planted in August 2006 at a spacing of 5.0 X 5.0 m. In this experiment pearl millet imposed in factorial randomized block design having three different levels of leaf mulching 0, 2 and 4 t ha^{-1} and three type of mulch *Azadirachta indica, Eucalyptus species* and *Leucaena leucocephala*. The treatments were replicated thrice. All other practices were kept normal in all plots as per recommendations. By thinning plant to plant distance was kept at about 15 cm. At maturity, plant height and dry matter were recorded by following the standard procedures. Analysis of variance technique was employed to analyze the data. Differences among the treatment means were compared using least significant difference (LSD) at 5% probability level (Steel and Torrie, 1984). The seed yield obtained from net plot was thoroughly cleaned; sun dried and weighed treatment wise. The net plot yield was then converted and expressed as kg/ha.The plants of each plot were cut from the ground level after removal of panicles. The stover was allowed dry thoroughly and final weight was recorded.

RESULTS AND DISCUSSION

Plant height increased with the progressive development of crop growth stages and reached to its maximum at maturity. Variations in plant height due to type and quantity of leaf mulch were found non-significant at all the crop growth stages except at harvest where quantity of mulch was found significant. At this stage 4 t ha^{-1} being at par with 2 t ha^{-1} recorded significantly higher plant height than 0 t ha^{-1} mulch, which was recorded the lowest plant height (Table 1).

Number of leaf plant^{-1} increasing with the advancement of crop growth stages up to 50 DAS after sowing and decreases thereafter. Type and quantity both were found non-significant at all the crop growth stages (Table 2) Number of tiller plant^{-1} was decreased with the progress of crop growth stages up to maturity. Type and quantity of mulch were found non significant at all the crop growth stages (Table 3). Total dry matter accumulation in plant increased with progression up to reproductive phase and reached to its maximum at maturity (Table 4). Total dry matter accumulation plant^{-1} was significantly affected by type and quantity of mulch at all the stages of crop growth except at 25 DAS where type of mulch was found non-significant.

Significant difference observed at 50 DAS in between *Leucaena leucocephala* and *Eucalyptus* sp. but no significant difference among other treatment combinations. At harvest *Leucaena leucocephala* was found significantly higher than *Azadirachta indica* while rest of the treatment combinations were found at par. Lowest dry matter accumulation plant^{-1} found in the *Azadirachta indica*species. Due to quantity of mulch total dry

Table 1: Plant height (cm) of pearl millet as influenced by type and quantity of tree leaf mulch under custard apple based agri-horti system

Treatment	Plant height (cm)		
	25 DAS	50 DAS	At harvest
Type of Mulch			
Azadirachta indica	86.7	158.1	172.5
Eucalyptus spp.	77.6	157.0	167.0
Leucaena leucocephala	73.6	152.9	173.0
S.Em. ±	7.4	5.1	3.3
CD at 5%	NS	NS	NS
Quantity of Mulch (t/ha)			
0	82.0	152.5	159.5
2	76.1	156.7	172.0
4	79.9	158.9	181.0
S.Em. ±	7.4	5.1	3.3
CD at 5%	NS	NS	10.0
TxQ Interaction	NS	NS	NS

Table 2: Number of leaf plant-1 of pearl millet as influenced by type and quantity of tree leaf mulch under custard apple based agri-horti system

Treatment	Number of leaves plant^{-1}		
	25 DAS	50 DAS	At harvest
Type of Mulch			
Azadirachta indica	13.4	17.9	17.1
Eucalyptus spp.	10.4	18.4	17.1
Leucaena leucocephala	10.9	17.5	17.0
S.Em. ±	1.2	6.7	6.5
CD at 5%	NS	NS	NS
Quantity of Mulch (t/ha)			
0	11.6	18.0	16.8
2	10.7	18.3	17.3
4	12.4	17.4	17.1
S.Em. ±	1.2	6.7	6.5
CD at 5%	NS	NS	NS
TxQ Interaction	NS	NS	NS

accumulation plant^{-1} was found significant at all the stages of growth. At 25 DAS after sowing 4 t ha^{-1} mulch being at par with 2 t ha^{-1} mulch produced significantly higher total dry matter accumulation plant^{-1} than 0 t ha^{-1} while at 50 DAS significant difference was observed only between 4 t ha^{-1} and 0 t ha^{-1} mulch ha^{-1} but rest of the treatment combination were remained at par. At harvest all the treatments were significantly different among themselves where 4 t ha^{-1} and 0 t ha^{-1} mulch produced significantly highest and lowest total dry matter accumulation plant^{-1} respectively.

Table 3: Number of tiller plant-1 of pearl millet as influenced by type and quantity of tree leaf mulch under custard apple based agri-horti system

Treatment	Number of tillers plant^{-1}		
	25 DAS	50 DAS	At harvest
Type of Mulch			
Azadirachta indica	1.36	0.36	0.30
Eucalyptus spp.	0.72	0.25	0.22
Leucaena leucocephala	1.00	0.36	0.30
S.Em. ±	0.24	0.13	0.10
CD at 5%	NS	NS	NS
Quantity of Mulch (t/ha)			
0	1.05	0.44	0.22
2	0.88	0.25	0.22
4	1.13	0.27	0.38
S.Em. ±	0.24	0.13	0.10
CD at 5%	NS	NS	NS
TxQ Interaction	NS	NS	NS

Result of the experiment revealed that growth parameters of pearl millet viz. plant height, number of leaf plant^{-1}, number of tiller plant^{-1} (Table 1 to 3) observed no significant variation due to type of mulch. Dry matter accumulation did not affect significantly due to type of mulch at 25 DAS while increased markedly at 50 DAS where *Leucaena leucocephala* produced significantly highest dry matter than *Azadirachta indica* and *Eucalyptus spp.* which were found at par with each other. At harvest *Leucaena leucocephala* being at par with *Azadirachta indica* produced significantly higher dry matter than *Eucalyptus spp.* (Table 4). Initially non-significant growth in dry matter accumulation might be due to inhibitory growth of leaves applied irrespective of the type of mulch.

Table 4: Number of tiller plant-1 of pearl millet as influenced by type and quantity of tree leaf mulch under custard apple based agri-horti system

Treatment	Dry matter accumulation plant^{-1} (g)		
	25 DAS	50 DAS	At harvest
Types of Mulch			
Azadirachta indica	7.55	40.52	69.97
Eucalyptus spp.	8.00	38.79	72.05
Leucaena leucocephala	8.88	43.30	75.2
S.Em. ±	0.78	1.06	1.17
CD at 5%	NS	3.18	3.52
Quantity of Mulch (t/ha)			
0	5.77	34.11	65.51
2	8.22	40.50	72.34
4	10.44	48.00	79.37
S.Em. ±	0.78	1.06	1.17
CD at 5%	2.36	3.18	3.52
TxQ Interaction	NS	NS	NS

At later stages of growth corresponding significant increases in dry weight obtained. Similar results were also obtained by Sale *et al.,* (2013). This increase in later part of the crop life might be due to decomposition of the leaf mulch and addition of the organic matter and nutrients in the soil. This can also be ascribed to availability of the conserved moisture in later half stressed period of the crop. Lowest dry matter in the plots where leaf mulch of *Eucalyptus spp.* was applied might be due to allelochemicals. Reigosal *et al.,* (2002) confirmed that *Eucalyptus globulus* has the most allelopathic effect and the largest number of allelochemicals (allelopathin). Alexander (1999) noted that the large area of ground surface beneath *Eucalyptus* remains completely bare or with very limited vegetation due to allelopathic effects. Similar results were obtained by Sale *et al.,* (2013) and Vanlalhluna and Sahoo (2011). The finding of the present study indicate that growth attributes of crop such as plant height and dry matter accumulation plant^{-1} had significant variation under mulches. The growth attributes had higher values with 4 t/ha mulchas compared to 0 t/ha mulch (no mulching). Enhanced growth parameters in 4 t ha^{-1} mulching might be due to addition of organic matter turned into humus and resultantly into increased nutrient retention capacity of the soil by increasing effective cation exchange capacity. Also the fact that mulch covers the soil thereby reducing the rate of water removal from the soil surface to the atmosphere i.e. evaporation. It's also protect the soil and its organic content from direct contact with warm air thus increasing soil microbial activity consequently encouraging decomposition is probably the reason for high growth. Similar findings were also made by Sale *et al.,* (2013), Vanlalhluna and Sahoo (2011) and Liasu*et al.,* (2007).

Data pertaining to grain yield (kgha^{-1}) as influenced by type and quantity of mulch are presented in Table 5. A critical examination of the data reflected that grain yield was significantly affected by type and quantity of mulch both. All the treatments were significantly different due to type and quantity of mulch. Highest grain yield (1657 kg ha^{-1}) was obtained with *Leucaena leucocephala,* however lowest grain yield (1554 kg ha^{-1}) obtained with the application of *Eucalyptus species* mulch though the differences were at par with *Azadirachta indica*. All the quantities of mulch were found significantly different among themselves. Highest yield (1735 kg ha^{-1}) was found with the application of 4 t mulch ha^{-1} while lowest (1412 kg ha^{-1}) with the application of 0 t ha^{-1}. Similar findings were also made by Sharma *et al.,* (1998), Bhattacharya *et al.,* (1995), Tilander (1993) and Mwangi and Peter (1989).

Table 5: Grain yield (kg ha^{-1}) of pearl millet as influenced by type and quantity of tree leaf mulch under custard apple based agri-horti system

Treatment	Grain Yield (kg ha^{-1})
Type of Mulch	
Azadirachta indica	1578
Eucalyptus spp.	1554
Leucaena leucocephala	1657
S.Em. ±	25
CD at 5%	75
Quantity of Mulch (t/ha)	
0	1412
2	1643
4	1735
S.Em. ±	25
CD at 5%	75
TxQ Interaction	NS

Table 6: Available N, P and K in soil of pearl millet as influenced by type and quantity of tree leaf mulch under custard apple based agri-horti system

Treatment	Available N (kg ha^{-1})	Available P (kg ha^{-1})	Available K (kg ha^{-1})
Type of Mulch			
Azadirachta indica	177.77	13.78	143.00
Eucalyptus spp.	171.88	12.63	139.22
Leucaena leucocephala	182.00	14.81	147.66
S.Em. ±	1.80	0.35	2.21
CD at 5%	5.41	1.05	6.62
Quantity of Mulch (t/ha)			
0	163.00	12.10	136.77
2	177.33	13.79	142.22
4	191.33	15.32	150.88
S.Em. ±	1.80	0.35	2.21
CD at 5%	5.41	1.05	6.62
TxQ Interaction	NS	NS	NS

Data regarding available N, P and K status in soil recorded after harvest of the crop are presented in Table 6. Variations in available N, P and K status were significant due to type and quantity of mulch. Available nitrogen, phosphorus and potassium significantly influenced by different type of mulch. Leucaena leucoce phalabeing at par with *Azadirachta indica* was significantly superior than Eucalyptus spp. mulch. Mulching of 4t ha^{-1} was also found significantly superior than remaining treatments.

CONCLUSION

On the basis of above experimental finding it is inferred that highest grain yield (1657 kg ha^{-1}) was obtained with *Leucaena leucocephala* and application of 4 t mulch ha^{-1} (1735 kg ha^{-1}).

CONFLICT OF INTEREST

All the author both individually and collectively, affirms that they do not possess any conflicts of interest either directly or indirectly related to the research being reported in the publication.

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Citation:

Kumar P, Singh AK, Kumar R, Singh RK, Om H, Chaudhary RS, KumarS, Bhushan A, Pathak SK and SK. Pandey.Pearl millet performance affected by tree leaf mulch under custard apple based agri-horti system. *Journal of AgriSearch***11**(1): 05-08