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Mulberry based integrated cropping system: An ideal approach for effective utilization of land resources in Sericulture

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Abstract

Mulberry (*Morus* spp.) is an important economic plant cultivated commercially for rearing Lepidopteran larvae of silkworm *Bombyx mori* L. and additionally for it's by product utilization. Owing to its wide adaptability to varied agro-climatic conditions, it can be easily cultivated and maintained as bush, dwarf and tree plantations. In current experiment an attempt has been made to formulate suitable design and layout for practicing integrated cropping or mixed cropping under different planting system of mulberry cultivation namely; pit, row and paired row system. Pit system was followed for one year old mulberry sapling with dimensions of 90 x 90 cm, row system with 60 x 90cm and paired row system with 90 + 150 x 60 cm. Three separate blocks were formulated for each system of the area of 15 x 10 feet (length x width). For the first block with pit system of plantation, boundaries were utilized for planting vegetables as intercrops along with mulberry saplings. Funnel, fenugreek and potato were grown on the side boundaries of the first blocks. Garlic and onion were grown as intercrop for second and third block having row and paired row system respectively. This is inspite of the fact that unlike other plants, mulberry provides two harvests of leaf annually. This is due to the fact that its annual growth cycle is such that it remains without foliage most of the time thereby causing least interception of solar light for the crops that can be grown underneath. From the current experiment, results have been drawn showing significant production of seasonal vegetables and mulberry leaf from each block. Moreover, the harvested vegetables and mulberry leaves showed good qualitative features too. This therefore provides an ideal choice of growing mulberry and seasonal vegetables simultaneously for effective land and resource utilization ensuring round the year cash flow to farmers. The current experiment emphasizes how the integration of mulberry and seasonal vegetables can help in improving productivity per unit area through effective land utilization and resource management.

Keywords: mulberry, sericulture, integrated, plantation, resource, utilization

Introduction

Intercropping can be defined as agricultural practice of cultivating or growing of two or more crops simultaneously on the same area of land for increasing the returns from unit area of land. The crops are not necessarily sown at exactly the same time and their harvest times may be quite different, but they are usually "simultaneous" for a significant part of their growing periods. It is a practice often associated with sustainable agriculture and organic farming. Intercropping is one form of polyculture, using companion planting principles. Intercropping may benefit crop yield or the control of some kind of pest, or may have other agronomic benefits. In intercropping, there is often one main crop and one or more added crops, with the main crop being the one of primary importance because of economic or food production reasons. The two or more crops used in an intercrop may be from different species and different plant families, or they may simply be different varieties or cultivars of the same crop species. Intercropping offers farmers the opportunity to engage nature's principle of diversity on their farms. Spatial arrangements of plants planting rates and maturity dates must be considered when planning intercrops. Intercrops can be more productive than growing pure stands.

The most common objective of intercropping is to produce a greater yield on a given piece of land by making use of resources that would otherwise not be utilized by a single crop and thereby to augment the income. Careful planning is required, taking into account the soil, climate, crops, and varieties. It is particularly important not to have crops competing with each other for physical space, nutrients, water, or sunlight. Intercropping of compatible plants also encourages biodiversity, by providing a habitat for a variety of insects and soil organisms that would not be present in a single crop environment. This biodiversity can in turn help to limit outbreaks of crop pests by increasing the diversity or abundance of natural enemies, such as spiders or parasitic wasps. Increasing the complexity of the crop environment through intercropping also limits the places where pests can find optimal foraging or reproductive conditions (Rajegowda *et al*. (2020) [13].

Sericulture is facing tough competition due to limited land

resources and competition with other agricultural crops. Therefore, there is an urgent need to develop mutual harmony between sericulture and agriculture for of sustainable co-existence. In general, most of the of the sericulture farmers have very small land holdings and depend mainly upon family labor and simple tools, they neither have the capacity to take risk nor have enough land to diversify the cropping system. Thus, by growing other of short duration crops, the farmer gets additional benefits from intercrops (Ahasn *et al*., 1989) [1]. Lot of work has already been done for integration of Sericulture with agriculture and horticulture (Gargi *et al*., 1997; Mir *et al*., 2018; Mir *et al*., 2022) [4, 12, 11]. Intercropping of mulberry with saffron in Kashmir yielded a good quality of mulberry leaf from the same field Where saffron was cultivated alone to generate work as well as good deal of returns to farmers during lean period when there are no operations related to saffron cultivation (Kaur *et al*., 2002) [5]. Various recent studies also suggest that mulberry can successfully intercropped with medicinal plants like *Aloe barbadensis*, *Asparagus racemosa*, *Acorus calamus* (Madhusudan *et al*., 2015) [9]. Thus, an attempt has been made to design suitable model with best possible combinations of mixed cropping system with mulberry as main crop for harnessing maximum benefits from sericulture.

Materials and Methods

The current study was developed and designed at P. G. Department of Sericulture, Poonch campus, university of Jammu. Experimental data for the selected parameters was recorded in the experimental plot with trail crops during the spring and autumn season during the year 2022 and 2023. In current experiment an attempt has been made to formulate suitable design and layout for practicing integrated cropping or mixed cropping under different planting system of mulberry cultivation namely; pit, row and paired row system. Pit system was followed for one year old mulberry sapling with dimensions of 90 x 90 cm, row system with 60 x 90cm and paired row system with 90 + 150 x 60 cm. Three separate blocks were formulated for each system of the area of 15 x 10 feet (length x width). For the first block with pit system of plantation, boundaries were utilized for planting vegetables as intercrops along with mulberry saplings. Funnel, fenugreek and potato were grown on the side boundaries of the first blocks. Garlic and onion were grown as intercrop for second and third block having row and paired row system respectively. The data obtained on various yield and quality parameters of mulberry and inter crops was subjected to statistical analysis on SPSS software for determination of ANOVA. Various parameters studied during the experiment included:

1. **Fresh leaf weight of 100 mulberry leaves (g):** For values of fresh leaf weight, 10 mature leaves were randomly picked up from the selected genotypes and weighed immediately on electronic weighing balance.
2. **Dry leaf weight of 100 mulberry leaves (g):** The same leaves were oven dried in hot air oven at 60°C for 6 hours till constant weight was attained and finally weighed on electronic weighing balance for dry leaf weight (g).
3. **Moisture percentage of mulberry leaf (%):** Moisture percentage of mulberry leaves of selected genotypes was calculated by formula:

$$\frac{\text{Fresh weight (W1)} - \text{Dry weight (W2)}}{\text{Fresh weight (W1)}} \text{ X } 100$$

4. **Moisture retention capacity (MRC) of mulberry leaf (%):** For MRC percentage the same mulberry leaf samples were rerecorded for fresh weight of the leaves (W1). After 3 hours, second weight of leaves (W2) was recorded. Same mulberry leaves were then kept in hot air oven for drying. After drying, the weight of dried mulberry leaves (W3) was recorded as final weight. From this observation was calculated for percentage of water in mulberry leaves, percentage of water loss and moisture retention capacity of the different mulberry varieties using the following formula

$$\text{Moisture \%} = \frac{W1 - W3}{W1} \text{x} 100$$

$$\text{Moisture loss \%} = \frac{W1 - W2}{W1} \text{x } 100$$

W1 – Fresh weight of leaves
W2 – Second weight of leaves
W3 – Dried weight of leaves
Moisture Retention Capacity (MRC) = 100 – Moisture loss %

5. **Internodal distance (cm):** For determination of internodal distance ten branches from selected plants were randomly selected and distance between the nodes present on the branch was measured with the help of measuring scale. The average was calculated from all the observed values to determine the mean value of internodal distance.
6. **No. of leaves per meter twig:** One meter of mulberry twig was selected in ten different branches and total no. of available leaves were counted to obtain an average no. of leaves per meter twig.
7. **Size of leaf (L×B):** Size of selected mulberry accessions was measured with the help of measuring scale for length and width values and size was determined in centimeters (cm) with the formula of length x width (Linnus 1990).
8. **Actual leaf area (cm2):** Actual leaf area of the selected genotypes was measure with the help of Graph method. In graph method, the randomly selected leaves were placed on graph paper, outline of the leaf was drawn with the help of pencil and total no. of full and partial grids of the graph was calculated to find out the actual leaf area.
9. **Intercrop yield Crop-I, Crop-II, Crop-III, Crop-IV (kg):** The crops grown along with mulberry as intercrops were harvested individually and weighed on weighing balance to get the exact value of yield.
10. **Mulberry Leaf yield per plant (kg):** For determination of leaf yield per plant, ten plants were randomly selected and entire foliage was harvested. The harvested leaves were weighed on electronic weighing balance and the value obtained was divided by ten to get the exact yield per plant. It can be expressed as:

$$\text{Leaf yield per plant (kg)} = \frac{\text{Total leaf yield of plants selected}}{\text{No. of plants selected}}$$

Table 1: The experiment was carried out as per the following experimental details

Design	RBD
Mulberry variety	Chackmajara
Treatments/Block	06
Plants/treatment/replication	20
Type of plantation	Bush type plantation
Blocks under study	03
System of plantation	Pit, Row and Paired row system
Dimensions of blocks	Block-I: 90 x 90 cm Block-II: 60 x 90cm Block-III: 90 + 150 x 60 cm
Area under study in each block	15 x 10 feet (length x width)
Age of plantation	2 years

Table 2: Experimental details

Treatment (T1)	Main crop	Intercrop vegetable
T1	Mulberry	Funnel
T2	Mulberry	Fenugreek
T3	Mulberry	Potato
T4	Mulberry	Garlic
T5	Mulberry	Onion
T6	Mulberry	Maize

Table 3: Sowing and harvesting details of vegetables

Main crop	Intercrop vegetables	Block	Time of sowing	Time of harvesting
Mulberry	Funnel	Block-I	November, 2022	March 2023
	Fenugreek	Block-II		
	Potato	Block-III		
	Garlic	Block-IV		
	Onion	Block-V		
	Maize	Block-VI	July, 2023	October 2023

Results and Discussion

Fresh and dry weight of 10 leaves

10 mature leaves of mulberry plants under different treatments were randomly harvested and weighed for fresh leaf weight on electronic weighing balance. Maximum fresh weight was recorded as 10.1g on an average for all the studied treatments. The same leaves were then oven dried for 6 hours at 60 °C for obtaining values of dry weight that recorded to be maximum as 3.3g.

Moisture percentage and MRC of mulberry leaf

The values for moisture percentage for different treatments was recorded on an average as high as 76.23 and 54.16 percent with MRC percentage of 73.24 percent.

Leaf shape: The shape of leaf of any plant is very important for morphological studies specially for the identification of the plant. In present study different types of mulches are used in different treatments and one is kept control under wild condition. Different leaf shapes are observed in plants under treatments shown in table-4. Generally, the ovate type of leaf shape was recorded for all the treatments and control exhibited ovate but smaller leaf.

Leaf size of mulberry: For determination of leaf size, the space formula of length × Width was applied and the maximum leaf size was recorded to be 126cm2 on an average.

Actual leaf area of mulberry leaf: In the current study actual leaf area was calculated by graph method. For the calculation of actual leaf area nearly 60-70 days old leaf was randomly picked from different treatments and placed on graph paper for drawing outline of the leaf. Total number of full and partial grids was counted manually to find out the actual leaf area for different samples. The maximum leaf area was recorded for mulberry plant growing under intercrop trial was recorded as 74cm2.

Mulberry Leaf yield per plant (kg)

For calculation of mulberry leaf yield per plant 10 mulberry plants were selected randomly and harvested to get the total yield that recorded as 2575g and the leaf yield per plant was recorded as 257.5g.

Intercrop yield Crop-I to VI (kg): The crops grown along with mulberry as intercrops were harvested individually and weighed on weighing balance to get the exact value of yield. The values obtained for yield harvest of various intercrops is detailed in Table-04 given below.

Table 4: The values obtained for yield harvest of various intercrops is detailed

Treatment (T1)	Main crop	Intercrop vegetable	Intercrop Yield (kg)
T1	Mulberry	Funnel	500g
T2	Mulberry	Fenugreek	500g
T3	Mulberry	Potato	5kg
T4	Mulberry	Garlic	8kg
T5	Mulberry	Onion	10kg
T6	Mulberry	Maize	10kg

Discussion

Mulberry is a fast-growing tree sharing good compatibility even under intercropping system and don't pose any serious harm to the adjacent intercrops. The current experiment revealed many interesting results pertaining to growth and quality parameters of mulberry when grown under intercropping system (Koul *et al*., 2008; Eskandari *et al*., 2009b) [7, 2]. The study revealed maximum fresh and dry weight as 10.1g, 3.3g resp. on an average for all the studied treatments that corresponds to the earlier results recorded by *et al*. The values for moisture percentage and MRC percentage were observed as 76.23 and 73.24 percent resp. indicating good quality of mulberry leaf. The current observations find close confirmation with earlier reports of (Eskandari, 2012b) [3]. In morphological observations, generally ovate type of leaf shape was recorded for all the treatments with maximum leaf area as 126cm2 and actual leaf area as 74cm2 on an average which confirmed the results of (Mahapatra, 2011; Zhang and Li, 2003) [10, 15] who stated that intercrops actually impart complementary effects for promoting mulberry growth. The crops grown along with mulberry as intercrops were harvested individually for observation of exact yield per intercrop. Leaf yield per plant is one of the most important criteria for deciding the suitability of mulberry for cultivation and silkworm rearing

as well. For the studied blocks, maximum leaf yield per plant in mulberry was recorded as 257.5g which found quite satisfactory independent of the stress of any kind posed by the intercrops. On the other hand, among all the six different intercrops, maize, onion and garlic revealed maximum yield of 10 kg, 10kg and 5 kg respectively that supports the results obtained by Singhvi and Katiyar (2009) [14] and Khan *et al*., (2015) [6]. Therefore, it can be assumed that cultivation of mulberry under intercropping system doesn't render any serious affect of the qualitative or quantitative growth of mulberry which find close similarity with the statements made by Mir *et al*., 2022 [11].

Conclusion

Mulberry (*Morus*) is a multipurpose tree that can be easily propagated and maintained as bush, dwarf plant or as and tree plantations. In bivoltine regions like UT of Jammu and Kashmir medium and tall bush plantation is commonly plasticized by the sericultural farmers. Being bivoltine crop, only two harvests are possible in the Jammu and Kashmir which poses great stress upon the farers to accelerate their incomes. Thus, intercropping could serve as a solution to the problem and farmers can try to generate additional income by adopting intercropping in their mulberry fields. In other sericultural progressive regions like Karnataka and Andhra Predesh etc. it is already a common practice to conduct mixed cropping system. Being a perennial crop with good foliage and root-spread, mulberry contributes to soil conservation and provides green cover. Thus, in sericulture sector, intercropping of seasonal vegetables and other crops could holds great prospects as it helps the farmers to realise full potential of the crop and ensures effective utilization of land resources.

Conflict of interests: None

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