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Seasonal variation of leaf yield in mulberry raised under bio and organic treatments in drought prone lateritic zone of West Midnapur,West Bengal

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Abstract

Seasonal sensitivity of mulberry in drought prone lateritic zone of Midnapore(West)was investigated under different organic and bio-fertilizer treatments during 2004-2006.The field experimental study was conducted for four successive seasons (Rainy, Autumn, Spring, Summer), from August to May in lateritic soil condition (having around pH of 5.6) with limited irrigation support in some areas of Midnapore(West) Districts, West Bengal, India. The plantation was raised in lateritic soil of Vidyasagar University campas (22^o 25/ N latitude and 87^o 17/ longitude) of Paschim Midinapore, West Bengal,India.. The study aimed to focus the effect of season on yield of mulberry during four consecutive seasons. Results with respect of yield of leaves in different crop seasons indicated that the August crop season /(rainy) exerted more influence than any other crop season and recorded the highest yield (3642.02 kg./ha./season), followed by February/ spring (3589.01 kg./ha./ season), November/ Autumn (3587.89 kg./ha./season) and May/ summer (3586.18 kg./ha./season) based on interaction between seasons and treatments.Although application of poultry manure along with bio fertilizers and reduced doses of inorganic fertilizers(T3) was found to be highest yielder (3916.03 kg./ha./season) influenced by August crop season; but equal attempts provided by same treatment also observed in other crop seasons highlighted the dominancy of treatments over seasons.

Introduction:

Sericulture is an agro-based industry, major activities of which comprises of food-plant cultivation to feed the silkworms which in turn spin silk cocoons. Mulberry (*Morus alba*) being a hardy perennial plant, possesses deep root system and grows luxuriantly in all the seasons except in late autumn and winter when the temperature and soil moisture go down below tolerable level (<15^{o}C). This low growth coupled with high leaf senescence; generate a high leaf scarcity for silkworm rearing during this period (Subramaniam *et al* 2011). Expected leaf yield of mulberry is pivotal that determines the success of sericulture. Traditional areas of sericulture, in the state of West Bengal, confine mostly to three big districts namely Murshidabad, Malda and Birbhum due to the congenial climatic conditions prevailing there. Out of the five silkworm crops, the high yielding bivoltine cross breed are usually reared during the autumn to spring season. (October - February) which is conducive to those silkworm rearing. This is because during this period as the ambient temperature is very low; hence, farmers can manipulate the temperature by using low cost technology in order to make the optimal temperature range from 26°C - 28°C. Unfortunately during this favourable period of silkworm rearing, availability of quality mulberry leaf is heavily reduced due to several characters like delayed sprouting of buds after pruning, slow growth and higher leaf senescence (Vijayan *et al* 1998). In West Bengal, the current popular mulberry variety, S1635, shows high seasonal variation in leaf production a sharp decrease in November (Autumn) and February (Winter), when the bivoltine silkworm rearing is at its peak (Moorthy and Das, 2007). This sharp decline in the leaf yield is mainly due to the early leaf maturity induced leaf fall during the colder months (Vijayan *et al.*, 1999). The average leaf fall % in S_{1635} under normal conditions was reported to be 31% under (60 × 60 cm.) spaced plantations, and it goes upto 33% under close planting systems (60 × 10 cm.) of irrigated conditions in West Bengal (Rahman *et al.*, 1999). Therefore, in order to increase the leaf yield to some extent even in adverse climatic condition and to reduce the dependency on continuous use of chemical fertilizers it is essential to apply, different organic residues like vermicompost and or poultry litter either singly or in combinations with the support of microbial manure.Nutrient status of leaves use to impart their impact on cocoon production and reeling performance. It has been widely accepted that organic farming alone could serve as a holistic approach towards achieving sustainable agriculture as it is nature based, environment friendly and ensures the conservation of resources for the future (Sangeetha and Thevanathan, 2010).Substantial researches have been carried out on this aspects for various zones of India and West Bengal in irrigated and rain fed conditions but no such attempt has so far been made for the laterite soil of Paschim Midnapore in particular for mulberry cultivation. Furthermore, it has also been observed that in acidic soil like many other crop plant, yield of mulberry is also less than its actual potential. The present investigation was thus carried out towards formulating a package of practices for mulberry cultivation in an integrated way in the laterite soil of Paschim Midnapore, with suitable organic–microbial manuring system at reduced level of inorganic fertilizer with less response to seasonal variation.

Materials and methods

A field experiment was conducted for four successive seasons (Rainy,Autumn,Spring,Summer) in the Vidyasagar University campas(22^o 25/ N latitude and 87^o 17/ longitude) of Midinapur (West), West Bengal, India. The soil of the experimental plot was acidic (pH 5.6) in nature having 0.41% organic carbon. The plantation was raised in lateritic soil of Vidyasagar University campas with eight months old mulberry saplings of S-1635 variety. The plantation was made with 49 plants in each plot ((5.4 x 5.4 m) with a spacing of 60cm. x 60cm between the plants and was laid out in randomized complete block design having five treatments and three replications. In the present study different organic manures and bio-fertilizers were applied after bottom pruning at 15 cm height . Recommended cultural practices for irrigated mulberry and the application of organic manures viz Farm yard manure (FYM) @ 20 tonns/ha/yr,Vermicompost @10 tonns/hac/year, poultry litter @7tonns/hac/year were being followed.Azotobactor(AZB) in the form of nitrofert bio-fertilizer was applied @20kg./hac./year after two to three days of every pruning near mulberry rhizosphere by making small furrows and then covered with soil in 4 equal splits, whereas phosphofert biofertilizer i.e. Arbuscular michorrhizal fungi(AMF) was applied at the rate of 100kg./hac./4years following the same process. The treatments included were:

T_1 = 20 MT/ha FYM + 336 kg N+180 kg P_2O_5+ 112 kg K_2O /ha /yr, T_2 = 10 MT/ha Vermicompost + AZB+AMF + 50% N + 33% P_2O_5 and K_2O /ha /yr of T_1, T_3 = 7 MT/ha Poultry-manure + AZB+AMF + 50% N + 33% P_2O_5 and K_2O /ha /yr of T_1, T_4 = 5 MT/ha Vermicompost + AZB AMF + 50% N + 33% P_2O_5 and K_2O /ha /yr of T_1, T_5 = 3.5 MT/ha Poultry-manure + AZB +AMF + 50% N + 33% P_2O_5 and K_2O /ha /yr of T_1.

Seasonal rainfall at West Midnapore varied from 5.99 mm. in December (which is least) to 307.1mm. in the month of August.(Table-1) Although the total rainfall in this area is about 1634 mm. On the basis of rainfall throughout the year, it could be divided into rainy season (July to October) when rainfall ranged from 211.80 mm to 307.10mm) pre monsoon covering April and May (rainfall 52.90-109.60mm) only and post monsoon or almost dry season starting from November to March when the rainfall was casual and as low as 5.9 in December and highest in the month of March (47.90). Maximum temperature of Paschim Midnapur varied between 28.660C in December and 41.330C in the month of April, whereas minimum temperature was between 9.66^{0}C in January to 25^{0}C in August.After 65 days of growth, the observations were recorded during the August, November, February and May, 2004-06 .Leaf yield was assessed by harvesting the leaves from all the plants available in net plots except the border line effect and then converted into yield per hectare. The organic carbon and pH of soil were estimated after the method of Black (1965).Vermicompost was prepared following the method of Kale (1986). Nutrient status of different composts was determined by the method of Jackson (1973). Data on yield was recorded after continuous application of organic inputs for four seasons. Analysis of variance was performed on four seasons (August, November, February and May).Seasonal effect on yield along with Season x Treatment interaction were studied and the overall mean of each of the 5 treatments critical difference value (P= 0.05) and (P= 0.01) was calculated.

Table–1 Seasonal variation in climatic factors at different Harvesting Seasons

Harvesting Seasons	Covering Month	Temperature range (^{0}C)				Relative Humidity range (%)	Average Relative Humidity (%)	Rainfall range (mm.)	Average Rainfall (mm.)
		Max.	Average Temp.	Min.	Average Temp.				
Spring (February)	December-February	28.66-	31.55	9.66-	10.99	67.00-	73.44	5.90-	22.40

		35.33		12.00		77.33		46.00	
Summer (May)	March-May	39.00-41.33	40.22	17.33-21.33	19.99	71.00-74.66	73.33	47.90-109.60	70.13
Rainy (August)	June-August	35.00-40.33	36.99	23.66-25.00	24.44	76.00-86.00	82.11	256.30-307.10	280.13
Autumn (November)	September-November	30.66-34.66	32.99	15.00-23.33	19.77	77.66-86.00	82.88	22.20-282.20	172.06

❖ Data have been acquired using Meteorological data of West Midnapore from 2004-2006 (Average of three years)

Results and Discussion:

Table– 2 Nutrient status of different composts

Different components	pH	Organic carbon %	N%	P%	K%
FYM	7.2	39.4	1.1	0.42	1.82
Vermicompost	7.2	15.4	1.65	0.92	1.2
Poultry Litter	7.0	7.7	3.1	2.84	2.70

Table-3 Effect of Organic manures and biofertilizers on leaf yield (kg./ha./season.) of Mulberry variety S_{1635} at different harvesting seasons (Average of two years)

Treatments	Seasons				Mean
	Rainy (August)	Autumn (November)	Spring (February)	Summer (May)	
T_1 (FYM +NPK)	3413.03	3266.54	3297.15	3325.87	3325.65
T_2 (Vermicompost+ *Azotobacter*+AMF+50% N+33% P_2O_5 and K_2O)	3712.17	3739.24	3642.51	3625.79	3679.93
T_3 (Poultry manure+ *Azotobacter*+AMF+50% N+33% P_2O_5 and K_2O)	3916.03	3893.75	3836.72	3841.33	3871.96
T_4 (1/2 Vermicompost+ *Azotobacter*+AMF+50% N+33% P_2O_5 and K_2O)	3659.47	3543.84	3624.91	3627.48	3613.92
T_5 (1/2 Poultry manure+ *Azotobacter*+AMF+50% N+33% P_2O_5 and K_2O)	3509.39	3496.11	3543.77	3510.42	3514.92
Mean	3642.02	3587.89	3589.01	3586.18	
SEm ±	65.324				
CD at 5%	Treatment 37.54, Season 33.58, Season x Treatment -75.08				
CD at 1%	Treatment 49.79, Season 44.53, Season x Treatment -99.58				

Table-3a. ANOVA for Leaf yield

SOURCE	DF	SS	MSS	VR(F)

Replication	2	8238		
Year	1	117138	117138	27.45**
Season	3	66526	22175	5.20**
Treatment	4	3912992	978248	229.25**
Y x S	3	455853	151951	35.61**
Y x T	4	156076	39019	9.14**
S x T	12	137205	11434	2.68**
Y x S x T	12	228946	19079	4.47**
Error	78	332843	4267	
Total	119	5415818		

*=Significant at 5% Level **=Significant at 1% Level

Table-2 shows the nutritional status of different composts and it revealed that percentage of N_2 and P_2O_5 was high in poultry litter followed by vermicompost. In respect of K_2O, FYM had higher percentage than vermicompost (1.8% in contrast to vermicompost 1.2%). Poultry litter had the highest K_2O% among these three. However, the pH of the composts ranging from 7 to 7.2 was thought to have increased the soil pH in one hand, and acted as buffering material on the other hand and thereby helped better utilization of other nutrients by the plant. Effect of organic manures and bio fertilizers on leaf yield of mulberry variety, S_{1635} in different crop seasons revealed that there were significant yield differences among the treated plots (Table-3). It was also inferred from the table that treatment T_3 (3871.96 kg./ha./season) was the best yielder and was immediately followed by treatment T_2 (3679.93 kg./ha./season),then followed by treatment T_4 (3613.92 kg./ha./season), treatment T_5 (3514.92 kg./ha./season) and T_1 (3325.65 kg./ha./season). Analysis of variance (Table-3a) with regard to the yield of leaves in different crop seasons indicated that the August crop season exerted more influence than any other crop season. It recorded a leaf yield (3642.02 kg./ha./season), followed by February (3589.01 kg./ha./season), November (3587.89 kg./ha./season) and May (3586.18 kg./ha./season). The CD value (33.58) at 5% level, in respect to season revealed that the performance in the crop seasons viz. November, February and May did not differed significantly but ensured that interaction between seasons and treatments at a significant level. T_3 was found to be highest yielder (3916.03 kg./ha./season) influenced by August crop season; and equal attempts provided by same treatment was observed in other crop seasons namely November (3893.75 kg./ha./season), February (3836.72 kg./ha./season) and May (3841.33 kg./ha./season),although the yield out of the said treatment was statistically at par among all these seasons. The T_2 was the next to best yielder in the November crop season (3739.24 kg./ha./season) showing almost same value in the August crop season (3712.17 kg./ha./season). However, February and May crop seasons showed equal impact on treatment T_1, although August and November crop seasons differed significantly. It was interesting to note that a decreasing trend in leaf yield was observed in Autumn in control plot(T1) but it was in increasing trend or at par for the rest of the plot which were treated by organic-microbial manures. Normally,photosynthesis during the winter season is limited by unfavorable environmental conditions (Ensminger *et al*, 2004). Seasonal changes in the rate of photosynthetic capacity were also observed as the photosynthesis increases in spring and decreases in autumn (Nilsson, 2001). But surprisingly few exceptional findings were also there where vermicomposts (T_2) were applied, and more or less similar trend was found with the application of poultry litter. So environmental conditions was incapable to hamper the plant productivity so much owing to the application of different bio and organic fertilizers.The beneficial effect of organic resources resulted in slow improvement in growth attributes, leaf yield and quality due to proper decomposition, mineralization, solubilizing effects and availability of sufficient nutrients as observed in T_2 and T_3. The above findings were in conformity with the study of Das et al. (1990), Setua *et al*. (2007) and Sudhakar *et al*.(2000) and Chakraborty *et al.,* (2008) in mulberry particularly in relation to the use of two types of biofertilizers,vermicompost and integrated nutrient management package,Ladha *et al*.(1996), Alainclement *et al*. (1998), Balasubramaniyan (2004), Khanda *et al*. (2005) and Chettri and Mondal (2005) in rice, Patidar and Mali (2001) in sorghum, Jat and Ahlawat (2004) in gram and fodder maize. Thus it is inferred from the above study out of four crop seasons treatment T_3 was the highest yielder and was influenced by August crop season and November crop season equally although the yield out of the said treatment was statistically at par among all these seasons. T_2 was the next to best yielder in the November crop season. In this context the findings of Ibeawuchi *et al*. (2006) could be mentioned who observed the leaf yield per plant was dependent on the quantity of nutrient made available from the poultry manure applied and have great potentials in the improvement of degraded ultisol. The present study has revealed that higher yield of leaves were observed in the August season when monsoon continued and favourable climatic conditions were prevailing for better growth of mulberry plant. It was apparent from the study as yield of mulberry leaves depends on the precipitation received in different crop seasons so it was highest in the rainy seasons (June to August) when regional rainfall varied from 256.30 mm to 307.10 mm and the result was in conformity with the findings Vijayashekara (2009) who also reported maximum leaf yield per plant during rainy season followed by winter season. Although it was also observed that availability of quality mulberry leaf was drastically reduced even in autumn (November crop season) due to application of poultry manure and vermicomposts (T3 & T2) along with organic manures and biofertilizers So the novelty of the above investigation was the application of poultry manures in order to produce higher leaf yield of mulberry irrespective of the seasonal changes.

Conclusion

The seasonal sensitivity of mulberry under different organic and bio-fertilizer treatments during 2004-2006 highlighted the influence of organic amendments rather than seasons.Bio and organic treatments has been shown to be a particular useful indicator of yield of mulberry leaves .This suggests that improved crop yields may be optimized with the application of different organic manures especially poultry manure along with biofertilizers and reduced dose of inorganic fertilizers in droght prone region irrespective of the continuous prevalence of considerable variability of seasonal factors.

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