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Growth and yield of maize under different agroforestry systems exposed to varying cultural treatments in Mizoram, India

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ABSTRACT

The growth and yield of maize under three multipurpose trees (*Alnus nepalensis, Gmelina arborea* and *Melia azedarach)* subjected to application of varying intensities of different mulches was evaluated during a 3-year period (2004-2006). Maize performed considerably well under *Alnus nepslensis* than under other trees and sole crop. Among the mulches, subabul leaf mulch brought increased yield (10 to 36%) in maize compared to sole crop and this increase was directly proportional to dose of mulch.

Key words: *Alnus nepalensis*; *Gmelina arborea*; *Melia azedarach*; mulches; maize growth; yield.

INTRODUCTION

Maize (*Zea mays* L.; family Poacea) ranks second to wheat in the world's cereal production. It is also one of the most important cereal crops in Mizoram, India, next to paddy. Maize is a very popular crop in Mizoram because it is high yielding, easy to process, readily digested, and lesser costs compared to other cereals. The crop is also known to grow under wider ecological amplitude and varied agro-ecological zones and most importantly as a component of widely practiced shifting cultivation; however, it depletes the soil nutrients very fast. The use of chemical fertilizers may enhance the yield of maize but the continuous use of chemical fertilizers may cause not only soil degradation but also may bring other ecological problems. Many workers[1-4] have advocated introduction of maize under or along with different nitrogen fixing tree species to boost its yield. Organic mulch may also aid in promoting its growth and yield especially under hilly terrain.[4-6]

The cost of maize cultivation can be reduced to a great extent if locally available mulches (weeds, subabul and straw) are used to conserve soil moisture. Besides, the compatibility of this crop to various indigenous tree species is yet another important issue for its wider cultivation/adoption. In order to find out the tree-crop compatibility and the role of various organic mulches, an experiment was initiated with three multipurpose

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trees (Alder, Neem and Gamar). The results on the growth and yield of maize under various cultural treatments during a 3-year period under different agroforestry systems are reported in this paper.

MATERIALS AND METHODS

Study area

The study area was located in the Mizoram University campus between 23°42' to 23°46' N latitude and 92°38' to 92°42' E longitude at an elevation of 845 m a.s.l. The site is moderately slope. The average slope of the study site is about 25%. The temperature variation is small throughout the year. The mean minimum and maximum summer and winter temperature recorded during the study period were 20-30°C and 8-18°C, respectively. The summer months are warm and wet whereas the winter months are moderate and dry. The mean annual rainfall is 2500 ± 105 mm. The soil of the study site is sandy loam, red brown in colour and acidic (pH 5.03-5.40) in nature.

Treatments

The experiment had 31 treatments laid down in randomized block design (RBD) with three replications totaling 93 subplots. The treatments consisted of one maize crop, three multipurpose trees such as *Alnus nepalensi* D. Don (Betulaceae), *Gmelina arbore* Roxb (Verbenaceae), *Melia azedarch* A. Juss (Meliaceae), three mulch types (rice straw, weeds, *Leucaena* leaves) and three mulch doses (6 t/ha, 8 t/ha, 10 t/ha) were applied to maize. A control (without mulch) was also maintained in each of the plots. The treatments included: T_1: Control (maize alone), T_2: *Alnus* + maize, T_3: *Alnus* + maize + rice straw - 6 tons, T_4: *Alnus* + maize + rice straw - 8 tons, T_5: *Alnus* + maize + rice straw- 10 tons, T_6: *Alnus* + weed - 6 tons, T_7: *Alnus* + weed- 8 tons, T_8: *Alnus* + weed - 10 tons, T_9: *Alnus* + *Leucaena* leaves - 6 tons, T_{10}: *Alnus* + *Leucaena* leaves - 8 tons, T_{11}: *Alnus* + *Leucaena* leaves - 10 tons, T_{12}: *Gmelina* + maize, T_{13}: *Gmelina* + maize + rice straw - 6 tons, T_{14}: *Gmelina* + maize + rice straw - 8 tons, T_{15}: *Gmelina* + maize + rice straw - 10 tons, T_{16}: *Gmelina* + weed - 6 tons, T_{17}: *Gmelina* + weed - 8 tons, T_{18}: *Gmelina* + weed - 10 tons, T_{19}: *Gmelina* + *Leucaena* leaves - 6 tons, T_{20}: *Gmelina* + *Leucaena* leaves - 8 tons, T_{21}: *Gmelina* + *Leucaena* leaves - 10 tons, T_{22}: Neem + maize, T_{23}: Neem + maize + rice straw - 6 tons, T_{24}: Neem + maize + rice straw - 8 tons, T_{25}: Neem + maize + rice straw - 10 tons, T_{26}: Neem + weed - 6 tons, T_{27}: Neem + weed - 8 tons, T_{28}: Neem + weed - 10 tons, T_{29}: Neem + *Leucaena* leaves - 6 tons, T_{30}: Neem + *Leucaena* leaves - 8 tons, T_{31}: Neem + *Leucaena* leaves - 10 tons. The trees were maintained at a uniform spacing of 2.5x2.5 m. Maize were planted at a uniform spacing of 60x40 cm. Mulches were applied immediately after sowing of the crop. Three weedings were carried out during a cropping period in order to prevent the growth of weeds and improve the crop growth. Chemical control measure and irrigation of any sort were not provided and the crop was raised purely under rain-fed condition. Observations were recorded in respect of vegetative growth such as average height, average diameter and average leaf length. Crop productivity in terms of the average number of cobs, average weight of grains and average number of grains were recorded after harvest.

Data analysis

Data are given as standard error of the mean. To determine statistical difference between the treatments, variance analysis and least significant difference (LSD) test were performed using Statistica 7.0 software programme. Level of significance was considered at $P \leq 0.05$.

Table 1. Vegetative growth of maize under different cultural treatments.

Treatments	Parameters for crop productivity		
	Average height (cm)	Average diameter (cm)	Average leaf length (cm)
T_1	166.54	4.15	77.37
T_2	168.42	4.61	80.21
T_3	169.96	4.82	82.36
T_4	172.85	5.65	84.06
T_5	175.36	5.86	86.30
T_6	168.32	4.52	79.34
T_7	169.75	5.01	80.04
T_8	171.76	5.22	81.22
T_9	173.08	5.58	82.75
T_{10}	176.91	5.79	84.33
T_{11}	179.83	5.93	86.62
T_{12}	168.04	4.43	79.42
T_{13}	170.31	4.61	80.69
T_{14}	172.52	5.62	81.91
T_{15}	167.09	5.68	82.09
T_{16}	167.56	4.50	77.52
T_{17}	168.93	4.99	78.33
T_{18}	170.12	5.13	80.01
T_{19}	171.53	5.37	80.82
T_{20}	173.55	5.49	82.11
T_{21}	175.63	5.52	83.43
T_{22}	168.32	4.59	79.56
T_{23}	170.85	4.70	81.23
T_{24}	173.21	5.47	83.47
T_{25}	167.35	5.72	84.99
T_{26}	168.02	4.61	78.90
T_{27}	169.64	5.09	79.19
T_{28}	170.72	5.20	80.54
T_{29}	172.60	5.43	81.50
T_{30}	174.22	5.57	83.16
T_{31}	177.34	5.61	84.35
S.E. m ±, n=24	0.33	0.21	0.09
C.D. (P=0.05)	0.48	0.33	0.13

Table 2. Crop productivity of maize under different cultural treatments

Treatments	Parameters for crop productivity		
	Average no. of cobs per plant	Average weight of grains per cob (gm)	Average no. of grains per cob
T_1	5.02	68.63	367.73
T_2	5.41	72.14	393.50
T_3	5.53	73.36	395.65
T_4	6.84	74.21	397.22
T_5	7.79	76.25	399.41
T_6	5.45	72.23	393.78
T_7	6.43	73.42	395.04
T_8	7.29	75.05	397.55
T_9	5.57	74.25	397.03
T_{10}	6.88	75.69	401.50
T_{11}	7.92	77.01	405.26
T_{12}	5.63	70.20	387.32
T_{13}	5.82	71.16	390.87
T_{14}	5.26	72.33	388.54
T_{15}	6.45	74.08	391.78
T_{16}	5.68	70.96	387.41
T_{17}	5.21	71.55	390.08
T_{18}	6.33	73.12	392.71
T_{19}	5.62	72.33	392.45
T_{20}	5.65	73.60	398.82
T_{21}	6.50	76.01	400.42
T_{22}	5.02	71.06	391.00
T_{23}	5.13	72.21	392.12
T_{24}	6.23	73.33	393.01
T_{25}	7.05	75.54	394.33
T_{26}	5.21	71.45	389.32
T_{27}	6.15	72.69	393.22
T_{28}	7.01	74.30	394.15
T_{29}	5.22	73.84	394.22
T_{30}	6.34	74.42	400.86
T_{31}	7.26	76.15	403.54
S.E. m ±, n=24	0.18	0.53	2.81
C.D. (P=0.05)	0.59	1.31	13.99

RESULTS

Growth characteristics

The plant height, basal diameter and leaf length of maize showed significant variation (P<0.05) between the treatment. The variations in these parameters were more pronounced between plots with *A. nepslensis.* These parameters showed significantly (P<0.05) higher values at *Leucaena* mulched plot compared to other treatments. Plant height of maize was increased with increasing rates of the application of mulch materials. Maximum plant height, basal diameter and higher leaf length were obtained with 10 t mulch/ha, followed by 8 t mulch/ha and 6 t mulch/ha. Maximum height (179.83 cm) was obtained under treatment with *Leucaena* leaf mulch (10 mulch/ha) that was grown along with *A. nepalensis* and minimum height (166.54 cm) was from maize grown under control without mulch (Table 1). The plant height, basal diameter and leaf length observed in the study was in the order *Leucaena* leaves mulch, followed by rice straw and weeds.

Crop productivity

The number of cobs, average grain weight and average grain number per cob were significantly (P<0.05) higher at the plots treated with *Leucaena* leaves mulch followed by rice straw and weed mulch respectively. The mean maximum number of cobs per plot (7.92), weight of grains per cob (5.93), number of grains per cob (405.26) were obtained under treatment with *Leucaena* leaves mulch that was grown along with *A. nepalensis* while the least was under control without mulches (Table 2). A higher rate of mulch application favoured bearing more number of cobs, higher grains weight and more number of grains per cob.

DISCUSSION

The vegetable mulch materials caused an appreciable increase in growth characteristics of maize when compared with the control treatment. Maximum plant height, basal diameter and higher leaf length were obtained with 10 t mulch/ha, followed by 8 t mulch/ha and 6 t mulch/ha. Maximum height (179.83 cm) was obtained under treatment with *Leucaena* leaf mulch (10 mulch/ha) that was grown along with *A. nepalensis* and minimum height (166.54 cm) was from maize grown under control without mulch. The mulches when spread on the ground must have suppressed the weed growth around the base of the crop while retaining soil moisture and could have added some nutrients through decomposition resulting in better growth. The role of organic waste as compost and mulch in increasing various crop yield such as rice,[7] corn yield,[8,9] pigeon pea,[10] potato,[11] and ginger[12] have been reported. Similarly, growth of maize was highest under vegetative mulch treatments, while un-mulch control plots showed significantly inferior growth.[13] Our results are also inconformity with the above workers.

The overall yield of maize was found to be significantly (P<0.05) higher in the treatments with *Leucaena* leaf mulch, rice straw and weeds mulch raised along with *A. nepalensis.* This is in accordance with the findings of many other workers[14-16] in which growth of maize as highest under vegetative mulch treatments. The present study depicts better growth and higher grain yield of maize by application of mulch as compared to un-mulched crops.

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