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RESEARCH ON THE INFLUENCE OF PLANTING DENSITY ON THE DYNAMICS OF BIOMASS ACCUMULATION IN BAMBOO PLANTATIONS UNDER THE CLIMATIC CONDITIONS SPECIFIC TO THE EMILIA-ROMAGNA REGION, ITALY

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Abstract

Although the cultivation of moso bamboo is currently seen as a challenge, in the near future this crop will certainly be regarded as a sustainable source of biomass, not only because it makes very good use of soils considered unsuitable for other crops, but especially due to the long lifespan characteristic of this species, its accelerated growth rate, the extraordinary capacity of plants for annual regeneration and the amount of biomass produced per unit area. The aim of the research was to determine the dynamics of biomass accumulation in distinct vegetation phases in 8-year-old bamboo plantations under the specific conditions of the temperate humid climate typical of the Emilia-Romagna region, Italy. The research results highlighted that, in an 8-year-old bamboo plantation, after 6 months of growth, the average of fresh and dry aboveground biomass yields were over 796 tons/ha, respectively over 619 tons/ha of dry biomass, thus demonstrating the importance of cultivating moso bamboo as a sustainable alternative energy source.

Key words: *moso bamboo, aerial biomass, alternative energy source, sustainability.*

INTRODUCTION

Those who produce the raw material are at the top of an industrial pyramid. No chemical treatments are used; bamboo is naturally antifungal and pesticide, and the organic quality of the soil and the purity of the underlying aquifers are maintained (Girard, 2013). This underground biomass enables bamboo to survive and regenerate when the surface biomass is destroyed by fire. Once developed, bamboo is also tolerant to floods and drough (Vitali & Dobrinoiu, 2020).

Several aspects of bamboo biology make it excellent for stabilizing unstable soils and preventing soil erosion, due to its extensive root systems, which can measure up to 100 kilometers per hectare and can live for approximately a century (Lobovikov et al., 2007).

Bamboo is included among phytoremediation plants for its ability to grow in polluted sites, absorb heavy metals present in the soil, and thus perform real remediation work. At present, this species helps more than 2 billion people meet their basic needs, while also representing a genuine source of growth for environmental resources (Vitali & Dobrinoiu, 2020). It is a species with high ecological plasticity, an extraordinary capacity for regeneration, very productive, versatile, easily accessible, and low-cost; it has great potential to improve the living standards of the population, especially in rural areas of developing countries (Ongugo et al., 2012). Bamboo has a number of characteristics desired in the biofuel market, such as low ash content and alkaline pH. The high calorific value (HHV) of bamboo is superior to most agricultural residues (Boundy et al., 2011). The moisture content of dry bamboo biomass is relatively low (8-23%) (Vitali & Dobrinoiu, 2020), compared to other plants used as a biomass source.

Recently, bamboo has emerged as a new source of biomass for energy production (Astier, 2013). Numerous studies and research have been conducted to assess the use of bamboo as an energy source, identifying bamboo as a viable

alternative for biomass resources to sustainably meet energy demands and generate additional income (Boyle, 2004). Bamboo biomass is used for co-generation to produce electricity or undergoes gasification and pyrolysis processes (Kerlero de Rosbo & De Bussy, 2012).

Direct combustion of bamboo biomass can also be applied on an industrial scale, for example, in the form of co-generation, for the production of thermal and electrical energy in thermal power plants or other facilities. Co-generation helps reduce the amount of fossil fuel used in these facilities (Poppens et al., 2013).

Bamboo biomass (dry matter) can be used through direct combustion in such a way that it is suitable for domestic use, such as cooking and heating homes in remote rural areas and for the poor. It is also possible to use biomass in co-generation plants to produce electricity. Biomass can undergo various conversion processes that produce so-called charcoal (similar to fossil coal), combustible gases, and biofuels that have characteristics similar to those of fossil fuels (Poppens et al., 2013).

In general, biomass is capable of taking on the role of fossil fuels in the future energy sector.

The two main advantages of biomass compared to fossil fuels are sustainability and CO2 emission levels. Bamboo biomass is a renewable source, which means it can be regenerated at a sustainable extraction rate (Vitali & Dobrinoiu, 2020). Although biomass processing (thermal conversion and biochemical conversion) also releases CO2, it does not contribute to the increasing concentration of greenhouse gases in the atmosphere, because the CO2 released through these processes is the same carbon dioxide from the atmosphere fixed through photosynthesis in bamboo plants (Sritong et al., 2012).

Currently, the electricity price of power plants using fossil fuels is higher than electricity produced from biomass, so biomass will be more cost-effective than fossil fuels, and the transition will occur naturally.

MATERIALS AND METHODS

The aim of the research was to evaluate the dynamics of aboveground biomass accumulation in moso bamboo plantations of different ages under the specific conditions of the Mediterranean climate characteristic of the Emilia-Romagna Region, Italy.

To achieve the objective outlined in the contract, the following partial objectives were targeted:

- Assessment of the dynamics of above-ground biomass accumulation (fresh substance) in moso bamboo (*Phyllostachys pubescens*) plantations of different ages;
- Assessment of the dynamics of above-ground biomass accumulation (dry substance) in moso bamboo (*Phyllostachys pubescens*) plantations of different ages;
- Assessment of the dynamics of above-ground total biomass yield accumulation in moso bamboo (*Phyllostachys pubescens*) plantations of different ages.

In order to assess the dynamics of biomass accumulation in bamboo plantations of different ages, against the background of using different planting densities, a two-factor experiment was designed according to the split-plot method, in three replications. The experimental factors tested during the research were:

Factor A – planting density, with 2 levels:

a1 – 1200 plants/ha;

a2 – 1080 plants/ha.

Factor B – plantation age, with 3 levels:

b1 – 2 years age;

b2 – 4 years age;

b3 – 8 years age.

By combining the two experimental factors studied, six experimental variants were obtained (Table 1), and the analysis and interpretation of the research results were carried out using the analysis of variance method, according to two-factor experiments, taking the average of the experimental variants tested in the research as the experimental control.

Table 1. Experimental variants tested during the research

Experimental Variants		Factor B		
		b1	b2	b3
Factor A	a1	V1 (a1b1)	V2 (a1b2)	V3 (a1b3)
	a2	V4 (a2b1)	V5 (a2b2)	V6 (a2b3)

The research was conducted in bamboo plantations of different ages (Figures 1 and 2), established in various locations in Italy. Control points (replications) with an area of 1 m^2 were set up along the diagonal of each plantation, where biometric measurements regarding the number of stems present on plants, the stems height and the stems diameter were carried out.

Figure 1. Collection and labeling of destructive plant samples on biomass components in 2- and 4-year-old bamboo plantations (Source: Personal archive)

Figure 2. Collection and weighing of destructive plant samples on biomass components in 8-year-old bamboo plantations (Source: Personal archive)

After conducting the biometric measurements, destructive plant samples were taken from each predetermined control point to determine the dynamics of biomass accumulation at each plantation.

The number of control points varied according to the area occupied by each bamboo plantation studied, with 2 control points for areas smaller than 1 ha, 3 control points for areas between 1-3 ha, and 4 or 5 control points for areas larger than 4 ha.

The prelevation of destructive plant samples was carried out in several repetitions, by cutting flush from the ground surface the stems present on the bamboo plants at the initial moment of the research and the new stems formed on the bamboo plants in 1 year of vegetation, given the extraordinary regenerative capacity of the plant, but also the specificity of the species *Phyllostachys pubescens* to differentiate new stems annually from the vegetative buds present in the root system (rhizomes).

The destructive samples were taken separated into the aerial components of the plants, namely stems, branches, and leaves, were labeled and weighed, resulting in the fresh biomass production reported per unit area.

After the determination of fresh biomass, the analysis samples were transferred for drying. The drying of the analysis samples was carried out at a temperature of 95°C for 48 hours for stems and branches, and at a temperature of 60°C for 24 hours for leaves. After drying, these samples were weighed and the results obtained were recorded for the purpose of determining the production of dry biomass achieved per unit area.

Observations and measurements made during the research.

The measurements carried out in the field focused on:

- the density of stems per unit area - by counting differentiated stems per m^2;
- the height of stems (m) by measuring the height of the stems from ground level to their top;
- the diameter of stems (cm) by measuring with calipers at the midpoint of the stems.

In the laboratory, the following measurements were made:

- fresh biomass of stems (kg/m^2) by weighing with the scale;
- fresh biomass of stem branches (kg/m^2) by weighing with the scale;

- fresh biomass of leaves (kg/m^2) - by weighing with the scale;
- biomass of stems d.m. (kg/m^2) - by weighing with the scale;
- biomass of stem branches d.m. (kg/m^2) - by weighing with the scale;
- biomass of leaves d.m.. (kg/m^2) - by weighing with the electronic scale;
- total fresh and dry biomass production (kg/m^2)
- by summing the biomass of its components, namely stems, branches, and leaves;
- total fresh and dry biomass production (to/ha)
- by relating it to the unit area.

RESULTS AND DISCUSSIONS

Results and discusions regarding the biometric parameters at moso bamboo plants

Research conducted in 2025 on moso bamboo plantations of different ages and established at different planting densities in the Emilia-Romagna Region, Italy, revealed, based on biometric determinations, that over 12 months of vegetation, the number of differentiated culms per unit area varied between 9.47 culms/m² and 13.87 culms/m², with the highest number of culms recorded in 2-year-old plantations, under a planting density of 1200 plants/ha (V1-a1b1).

Compared to the experiment average (11.18 culms/m²), the number of culms per m² showed highly significant positive differences (***) in the experimental variants where the planting density was 1200 plants/ha (V1, V2, and V3) and highly significant negative differences (ooo) in the experimental variants where the planting density was 1080 plants/ha (V4, V5, and V6), regardless of the plantation age (Table 2).

Table 2. Biometric parameters on moso bamboo plants (Emilia-Romagna, Italy)

Experimental plot	Stems number/m^2	Diff.	Sign.	Stems height (m)	Diff.	Sign.	Stems diameter (cm)	Diff.	Sign.
V1 (a1b1)	13.87	2.69	***	2.43	-3.52	ooo	1.47	-3.73	ooo
V2 (a1b2)	12.03	0.85	***	3.23	-2.72	ooo	2.03	-3.17	ooo
V3 (a1b3)	11.71	0.53	***	11.15	5.20	ooo	10.82	5.62	ooo
V4 (a2b1)	10.13	-1.05	ooo	2.72	-3.23	ooo	1.93	-3.27	ooo
V5 (a2b2)	9.84	-1.34	ooo	3.73	-2.22	ooo	2.47	-2.73	ooo
V6 (a2b3)	9.47	-1.71	ooo	12.41	6.46	***	12.47	7.27	***
Average (Control)	11.18	Ctrl.	Ctrl.	5.95	Ctrl.	Ctrl.	5.20	Ctrl.	Ctrl.
	$LSD_{5\%}$ = 0.040; $LSD_{1\%}$ = 0.074; LSD $L_{0.1\%}$ = 0.185			$LSD_{5\%}$ = 0.010; $LSD_{1\%}$ = 0.018; $LSD_{0.1\%}$ = 0.046			$LSD_{5\%}$ = 0.009; $LSD_{1\%}$ = 0.013; $LSD_{0.1\%}$ = 0.019		

The height of the stems after 12 months of growth reached values ranging from 2.43 m (V1) to 12.41 m (V6), with the most intense rate of stem growth and development recorded in plants aged 8 years, where stem heights varied between 11.15 m (V4) and 12.41 m (V6), showing very significantly negative differences (ooo) compared to the experiment average, with the exception of the experimental variant V6, where the differences were very significantly positive (***) (Table 2).

The diameter measured at the middle of the moso bamboo culms recorded values ranging from 1.47 cm to 12.47 cm, with the largest diameter culms identified in 8-year-old plants, due to the use of a planting density of 1080 plants/ha when establishing the plantation. Differences from the experimental mean were statistically highly significantly negative (ooo), regardless of the experimental factors tested in the research, with the exception of experimental variant V6, where the difference was highly significantly positive (***), following the provision of a density of 1080 plants/ha at the time of plantation establishment (Table 2).

Results and discusions regarding the dynamics of aboveground fresh biomass accumulation

By analyzing the dynamics of biomass accumulation in the aerial organs of moso bamboo plants, it is observed that the largest amount of fresh biomass was accumulated in the stems, with values of this biometric parameter ranging from 3.513 kg/m² (35.13 to/ha), the minimum value obtained in 2-year-old plants under a planting density of 1,200 plants/ha (V1), to 60.173 kg/m² (601.73 to/ha) in 8-year-old plants with a planting density of 1,080 plants/ha (V6).

Compared to the experiment average of 23.39 kg/m² (233.9 to/ha), statistically significant differences were recorded, ranging from very significantly negative (ooo) in 2- and 4-year-old bamboo plants to very significantly positive (***) in 8-year-old plants, regardless of the planting density established at the time of plantation establishment (Tables 3 and 4).

Table 3. Aerial fresh biomass (kg/m²) accumulated in moso bamboo plantations

Experimental plot	Stems fresh biomass (kg/m²)	Diff.	Sign.	Branches fresh biomass (kg/m²)	Diff.	Sign.	Leaves fresh biomass (kg/m²)	Diff.	Sign.
V1 (a1b1)	3.513	-19.88	ooo	2.361	-3.17	ooo	2.138	-3.80	ooo
V2 (a1b2)	6.133	-17.26	ooo	4.241	-1.30	ooo	4.361	-1.58	ooo
V3 (a1b3)	59.670	36.28	***	9.503	3.98	***	10.461	4.52	***
V4 (a2b1)	3.936	-19.45	ooo	2.815	-2.72	ooo	2.638	-3.30	ooo
V5 (a2b2)	6.917	-16.47	ooo	4.513	-1.02	ooo	4.685	-1.26	ooo
V6 (a2b3)	60.173	36.78	***	9.791	4.26	***	11.334	5.39	***
Average (Control)	23.39	Ctrl.	Ctrl.	5.53	Ctrl.	Ctrl.	5.94	Ctrl.	Ctrl.
	$LSD_{5\%} = 0.008$; $LSD_{1\%} = 0.016$; $LSD_{0.1\%} = 0.040$			$LSD_{5\%} = 0.001$; $LSD_{1\%} = 0.002$; $LSD\ L_{0.1\%} = 0.005$			$LSD_{5\%} = 0.002$; $LSD_{1\%} = 0.004$; $LSD_{0.1\%} = 0.011$		

The same dynamic of biomass accumulation is observed when analyzing the fresh biomass accumulated in the branchings of the stems, with recorded variations ranging from 2.361 kg/m² (23.61 to/ha) (V1) to 9.791 kg/m² (97.91 to/ha) (V6), with 8-year-old bamboo plants accumulating over 9.5 kg/m² (95 to/ha) of fresh biomass in the stem branchings, regardless of plant density. It is observed that in the case of 4-year-old plants, the amount of fresh biomass accumulated in the stem branches exceeded 4 kg/m² under both planting densities (V2 and V4), while for 2-year-old plants, a biomass amount of over 2 kg/m² (23 to/ha) was determined (Tables 3 and 4).

Table 4. Aerial fresh biomass accumulated on the surface unit in moso bamboo plantations

Experimental plot	Stems fresh biomass (to/ha)	Diff.	Sign.	Branches fresh biomass (to/ha)	Diff.	Sign.	Leaves fresh biomass (to/ha)	Diff.	Sign.
V1 (a1b1)	35.13	-198.77	ooo	23.61	-31,76	ooo	21.38	-37.98	ooo
V2 (a1b2)	61.33	-172.57	ooo	42.41	-12,96	ooo	43.61	-15.75	ooo
V3 (a1b3)	596.70	362.80	***	95.03	39,66	***	104.61	45.25	***
V4 (a2b1)	39.36	-194.54	ooo	28.15	-27,22	ooo	26.38	-32.98	ooo
V5 (a2b2)	69.17	-164.73	ooo	45.13	-10,24	ooo	46.85	-12.51	ooo
V6 (a2b3)	601.73	367.83	***	97.91	42,54	***	113.34	53.98	***
Average (Control)	233.90	Ctrl.	Ctrl.	55.37	Ctrl.	Ctrl.	59.36	Ctrl.	Ctrl.
	$LSD_{5\%} = 0.040$; $LSD_{1\%} = 0.074$; $LSD_{0.1\%} = 0.185$			$LSD_{5\%} = 0.572$; $LSD_{1\%} = 1.068$; $LSD_{0.1\%} = 2.674$			$LSD_{5\%} = 0.009$; $LSD_{1\%} = 0.013$; $LSD_{0.1\%} = 0.019$		

The differences compared to the experiment's average were statistically highly significant negative (ooo) for 2-year-old and 4-year-old plants, whereas the differences were statistically highly significant positive (ooo) for 8-year-old bamboo plants (Tables 3 and 4), regardless of the density established at the time of plantation establishment (V3 and V6).

In the leaves of moso bamboo plants, larger amounts of fresh biomass accumulated compared to the amounts of biomass accumulated in the stem branches, with values ranging from 2.138 kg/m² (21.38 to/ha) to 11.334 kg/m² (113.34 to/ha), the highest amounts of biomass being observed in plants aged 8 years (Tables 3 and 4), for which the differences from the average of the trial taken as the experimental control were very significantly positive (***) from a statistical point of view, due to the practice of the two planting densities examined during the study (V3 and V6).

Research results regarding the dynamics of aboveground dry biomass accumulation The aerial organs of moso bamboo plants of different ages contributed differently to the accumulation

of dry biomass per unit area, with the greatest contribution coming from the stems, with over 2.972 kg of dry biomass/m² (29.72 to/ha) in 2-year-old plants, over 5.973 kg of dry biomass/m² (59.73 to/ha) in 4-year-old plants, and over 49.608 kg of dry biomass/m² (496.08 to/ha) in 8-year-old plants (Table 5).

Table 5. Aerial dry biomass accumulated in moso bamboo plantations (kg/m²)

Experimental plot	Stems dry biomass (kg/m²)	Diff.	Sign.	Branches dry biomass (kg/m²)	Diff.	Sign.	Leaves dry biomass (kg/m²)	Diff.	Sign.
V1 (a1b1)	2.972	-16.72	ooo	1.812	-2.16	ooo	2.019	-2.30	ooo
V2 (a1b2)	5.973	-13.72	ooo	3.669	-0.30	ooo	3.813	-0.51	ooo
V3 (a1b3)	49.608	29.92	***	5.963	1.99	***	6.350	2.03	***
V4 (a2b1)	3.227	-16.46	ooo	2.106	-1.86	ooo	2.394	-1.93	ooo
V5 (a2b2)	6.236	-13.45	ooo	3.851	-0.12	ooo	4.095	-0.23	ooo
V6 (a2b3)	50.111	30.42	***	6.431	2.46	***	7.223	2.90	***
Average (Control)	19.69	Ctrl.	Ctrl.	3.97	Ctrl.	Ctrl.	4.32	Ctrl.	Ctrl.
	$LSD_{5\%} = 0.001$; $LSD_{1\%} = 0.001$; $LSD_{0.1\%} = 0.002$			$LSD_{5\%} = 0.005$; $LSD_{1\%} = 0.011$; $LSD_{0.1\%} = 0.030$			$LSD_{5\%} = 0.003$; $LSD_{1\%} = 0.006$; $LSD_{0.1\%} = 0.014$		

The branching of the culms contributed over 1.812 kg of dry biomass/m² (18.12 tons/ha) in 2-year-old bamboo plantations, over 3.669 kg of dry biomass/m² (36.69 tons/ha) in 4-year-old plantations, with the highest amount of dry biomass recorded in the differentiated branches of 8-year-old bamboo plant culms, namely over 5.963 kg of dry biomass/m² (59.63 tons/ha).

The contribution of leaves to the production of dry biomass was higher than that of the culm branches, ranging between 2.019 kg of dry biomass/m² (20.19 tons/ha) and 7.223 kg of dry biomass/m² (72.23 tons/ha). By practicing a planting density of 1080 plants/ha, the rate of biomass accumulation increased significantly throughout the growing season of bamboo plants, regardless of their age.

Compared to the average experience in the experimental variants where the plants were 2 and 4 years old, very significant negative differences (ooo) were recorded in terms of dry biomass accumulation in the aerial parts of the bamboo plants, while in the 8-year-old bamboo plantations, very significant positive increases (***) in the rate of dry biomass accumulation were achieved, regardless of the plant density established at the time of plantation establishment (Table 6).

Table 6. Total aerial dry biomass accumulated on the surface unit in moso bamboo plantations (To/Ha)

Experimental plot	Stems dry biomass (to/ha)	Diff.	Sign.	Branches dry biomass (to/ha)	Diff.	Sign.	Leaves dry biomass (to/ha)	Diff.	Sign.
V1 (a1b1)	29.72	-167.16	ooo	18.12	-21.60	ooo	20.19	-22.97	ooo
V2 (a1b2)	59.73	-137.15	ooo	36.69	-3.03	ooo	38.13	-5.03	ooo
V3 (a1b3)	496.08	299.20	***	59.63	19.91	***	63.50	20.34	***
V4 (a2b1)	32.27	-164.61	ooo	21.06	-18.66	ooo	23.94	-19.22	ooo
V5 (a2b2)	62.36	-134.52	ooo	38.51	-1.21	ooo	40.95	-2.21	ooo
V6 (a2b3)	501.11	304.23	***	64.31	24.59	***	72.23	29.07	***
Average (Control)	196.88	Ctrl.	Ctrl.	39.72	Ctrl.	Ctrl.	43.16	Ctrl.	Ctrl.
	$LSD_{5\%} = 0.026$; $LSD_{1\%} = 0.054$; $LSD_{0.1\%} = 0.156$			$LSD_{5\%} = 0.017$; $LSD_{1\%} = 0.036$; $LSD_{0.1\%} = 0.107$			$LSD_{5\%} = 0.099$; $LSD_{1\%} = 0.229$; $LSD_{0.1\%} = 0.730$		

Research results regarding total aerial biomass yield

The total production of fresh aerial biomass in the bamboo plantations studied varied over the course of a growing year from 80.12 tons/ha in 2-year-old plantations, with a planting density of 1200 plants/ha (V1), to 812.98 tons/ha in 8-year-old plantations, with a planting density of 1080 plants/ha (V6). The plants showed an extraordinary capacity for growth and vegetative development, especially during the first six months of the growing season (Table 7). In the case of 4-year-old plantations, total fresh biomass yields of over 147 tons/ha were

recorded, regardless of the planting scheme established at the establishment of the plantations.
Compared to the experiment average (348.64 tons/ha), the differences recorded in the 6 experimental variants tested during the research showed a highly significant negative statistical assurance (ooo) in the case of 2- and 4-year-old Moso bamboo plantations (V1, V2, V4, and V5), while in 8-year-old plantations, fresh biomass production increases of over 447 tons/ha were recorded with highly significant positive statistical assurance (***) (Table 7).

Table 7. Total aerial fresh and dry biomass yield at moso bamboo plantations (to/ha)

Experimental plot	Fresh biomass yield (to/ha)	Difference	Significance degree	Dry biomass yield (to/ha)	Difference	Significance degree
V1 (a1b1)	80.12	-268.52	ooo	68.03	-211.73	ooo
V2 (a1b2)	147.35	-201.29	ooo	134.55	-145.21	ooo
V3 (a1b3)	796.34	447.70	***	619.21	339.45	***
V4 (a2b1)	93.89	-254.75	ooo	77.27	-202.49	ooo
V5 (a2b2)	161.15	-187.49	ooo	141.82	-137.94	ooo
V6 (a2b3)	812.98	464.34	***	637.65	357.89	***
Average (Control)	348.64	Control	Control	279.76	Control	Control
	$LSD_{5\%} = 0.033$; $LSD_{1\%} = 0.058$; $LSD_{0.1\%} = 0.135$			$LSD_{5\%} = 0.010$; $LSD_{1\%} = 0.018$; $LSD_{0.1\%} = 0.046$		

Analyzing the total dry biomass production resulting from the interaction of the two experimental factors tested in the research, it can be observed that the values of this biometric parameter ranged between 68.03 tons/ha and 77.27 tons/ha in 2-year-old Moso bamboo plantations, between 134.55 tons/ha and 141.82 tons/ha in 4-year-old plantations, and between 619.21 tons/ha and 637.65 tons/ha in 8-year-old plantations, where very significant positive increases (***) in dry biomass production of over 339 tons/ha were recorded by ensuring a planting density of 1200 plants/ha and over 357 tons/ha with a planting density of 1080 plants/ha (Table 7).
The other experimental variants studied recorded, compared with the experiment's average taken as control, very significant negative differences (ooo) ranging between 137.94 tons/ha and 211 tons/ha from a statistical point of view (Table 7).

CONCLUSIONS

Based on the observations and measurements carried out between April 2025 and January 2026 in Moso bamboo plantations of different ages located in the Emilia-Romagna Region, Italy, the following conclusions can be drawn:
During the research period, due to the pedoclimatic conditions specific to the locations where the studies were conducted, the values of the biometric parameters recorded quite significant variations, influenced by the two planting schemes taken into study.
Under the condition of ensuring a planting density of 1200 plants/ha, the stem density per unit area recorded average values of 13.87 stems/m², with an average stem height of 2.43 m and an average stem diameter of 1.47 cm in 2-year-old bamboo plantations; 12.03 stems/m² in 4-year-old plantations with an average height of 3.23 m and a diameter of 2.03 cm; and 11.71 stems/m² in 8-year-old plantations, with a height of 11.15 m and a diameter of 10.82 cm.
By increasing the nutrition space, as a result of ensuring a planting density of 1080 plants/ha, the stem density per unit area decreased to 10.13 stems/m² for 2-year-old bamboo plants, with stems reaching a height of 2.72 m and a stem diameter of 1.93 cm, 9.84 stems/m² for 4-year-old plants, with an average stem height of 3.73 m and a diameter of 2.47 cm, and 9.47 stems/m² with an average height of 12.41 m and a stem diameter of 12.47 cm for 8-year-old plants.
The largest contribution to total fresh aboveground biomass production came from the stems, where, by ensuring a planting density of 1080 plants/ha, over 32 tons of fresh biomass/Ha were accumulated for 2-year-old bamboo plants, over 62 tons of fresh biomass/ha for 4-year-old plants, and over 501 tons of fresh biomass/ha for 8-year-old bamboo plants.

The highest yields of fresh aerial biomass after 9 months of vegetation in moso bamboo plants were recorded in the experimental variants where a planting density of 1080 plants/ha was used when establishing the plantations, with values of 93.89 to/ha in 2-year-old plantations, 161.15 to/ha in 4-year-old plantations, reaching maximum values of 812.98 to/ha in 8-year-old plantations.

The total dry biomass yield over 9 months of vegetation in the plants recorded values of 77.27 to/ha in 2-year-old bamboo plantations, 141.82 to/ha in 4-year-old plantations, reaching maximum values of 637.65 to/ha in 8-year-old plantations, in the context of maintaining a density of 1080 plants/ha when establishing the plantations.

Based on the results obtained in the present research, it can be stated that moso bamboo plantations represent a sustainable source for biomass production intended for bioenergy due to the longevity of the plants (80-100 years), their extraordinary annual regeneration capacity, the intensive rate of vegetative growth and development of the plants, and the superior yields achieved per unit area compared to other energy plant species.

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