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Effect of Spacing and Root Trimming on Growth and Yield of Water Mimosa (*Neptunia prostrata* L.)

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A B S T R A C T

An experiment was conducted to study the effect of spacing and root trimming on growth and yield of water mimosa. The present study was carried out at the experimental field of College of Agriculture, Central Agricultural University, Iroisemba, Imphal, Manipur during *kharif* season, 2021. The experiment was laid out in factorial randomized block design (FRBD) with 9 spacings, Non-root trimming and Root trimming methods with three replications. The primary data on growth and yield of water mimosa cultivation was collected to study the growth and yield. The main finding on this study unveiled that the treatment S5T2 (4.5ft x 1.5ft with root trimming method) which is par with treatment S5T1 (4.5ft x 1.5ft without root trimming) has the maximum yield of all other treatments.

Introduction

In Manipur, a large number of wild vegetables are found and well acclimatised since long time. Water mimosa (*Neptunia prostrata* L.) is one of them and local people prefer this vegetable very much due to its aroma and taste similar to tree bean (*Parkia roxburghii* G. Don). Tree bean is most prominent high value fruit vegetable (legume pod) desired by the local people. Its harvesting is ended during April. In the month of April, its cost is raised up to Rs. 25/pod. After April no fresh pods of tree bean are available. It is succeeded by water mimosa as the taste and aroma of the tree bean is similar to water mimosa. Perhaps, it may be due to they belong to the same family. During the month of May, the cost of water mimosa is Rs. 30 - 40/bundle comprising of 4 to 5 shoots or branches. Water mimosa is a wild aquatic legume herb locally known as *Ekaithabi*. It can be grown in ponds, small ditches, marshy and swampy areas where no other crops can be grown. Being high price vegetable, small and marginal farmers can earn a handsome amount of income by growing it. The North-eastern region of India particularly, Manipur provides a favourable condition for mass propagation of water mimosa owing to its ample rainfall, humidity and moderate range of temperature (Singh, 2017).

Water mimosa is nutritionally high in Calcium. In a serving of 100 g edible portion of shoots contain Ca 387 mg, moisture 89.4 g, protein 6.4 g, fat 0.4 g, carbohydrates 0.8 g, fibre 1.8 g, ash 1.2 g, P 7 mg, Fe 5.3 mg, vitamin A 5155 IU, vitamin B_1 0.12 mg, vitamin B_2 0.14 mg, niacin 3.2 mg and vitamin C 1.8 mg and the energy value is 134 kJ/100 g (Anon., 1981). Juice of the stem and roots are used for medicinal purposes. The juice of the stem is squeezed into the ear to cure earache.

The root is used as an external remedy for necrosis of the bones of the nose and hard palate. The root is used in the advanced stage of syphilis. Whole plant extract exhibited cytotoxic activity on neoplastic cell lines. Extract of the herb exhibited hepatoprotective activity (Tangkanakul *et al.,* 2006).

In human when the imbalance between antioxidant defence system and oxidative stress is interrupted, it can cause cellular damage by initiating chemical chain reactions such as lipid peroxidation of cellular membranes, alteration of lipid–protein interaction, enzyme inactivation and DNA breakage, and in the end, to cause cellular dysfunction and cell death (Rahal *et al.,* 2014; Uttara *et al.,* 2009).

Oxidative stress plays a critical role in the pathogenesis of various disorders and diseases such as carcinogenesis, coronary heart disease, atherosclerosis, diabetes, arthritis, Alzheimer's disease, cardiovascular disease, Parkinson's disease, and age-related disease (Rajendran *et al.,* 2014; Rochette *et al.,* 2013). The demand for natural antioxidants has recently increased because of toxicity, suspected carcinogenic potential and other adverse effects of synthetic antioxidants (Yoon *et al.,* 2010). Thus, there is growing interest in replacing synthetic antioxidants with natural resources, and much attention has been focused on natural antioxidants in maintaining the health of human body and preventing and treating diseases (Falowo *et al.,* 2014; Li *et al.,* 2014; Liu *et al.,* 2014). Water mimosa could be suggested as a potential natural source of antioxidant and antidiabetic compounds that can be used for the prevention or treatment of diabetes. The antioxidant in this plant has free radical scavenging capabilities (Lee *et al.,* 2014). Niacin plays an essential part in the metabolic process of living cells and is involved in both DNA repair and production of steroid hormones in the adrenal glands. In Manipur it is used as vegetable for preparation of *Eromba* (mashed vegetables with water), *Kanghou* (stir-fries), *Singju* (salad with fermented fish) and even as curries.

Water mimosa is cultivated in Manipur by the small and marginal farmers using their traditional knowledge for earning extra income but these traditional cultivation practices are not yet standardised.

Therefore, the present investigation is considered essential to standardise the traditional cultivation practices to promote or boost up the growth and yield of water mimosa. Perhaps the present study may be the first experiment on the cultivation aspect of research work in water mimosa.

Materials and Methods

The experiment was conducted at the experimental field of College of Agriculture, CAU, Imphal, Manipur during the *kharif* season, 2021. The soil was clay slightly loam with an average organic carbon contain 1.12 per cent. The average pH of the soil was 4.98 with a high quantity of available nitrogen and medium quantity of available phosphorus and potassium.

The experiment was conducted in Factorial Randomised Block Design (FRBD) with three replications. In the experiment, for collection of data on economic characters, single random sampling technique was followed and a single competitive plant was taken as a sample unit.

A sample size of 10 plants from each plot was taken for each character parameter. The field was prepared with two ploughing to make the field into favourable condition for the cultivation. Chemical fertilizers @ 40kg N: 50kg P_2O_5: 40kg K_2O per hectare was applied as a basal dose. NEO Leaf granules, an organic Bio-stimulant, were applied @ 12 kg/ha. Planting of water mimosa were done in such a way that the shoots are attached to the coconut coir rope in an alternate side in a specific spacing to the rope which floats on the surface of water with the support of used empty water bottles for floatation purpose. While tying the shoots to the rope, the shoot tips should always be kept at upward position on the surface of water not submerging into the water. The ropes are tight to the bamboo stakes in such a mechanism that the rope can be adjusted to the increasing or decreasing level of water.

Treatment details

Spacings

S1 – 3ft x 1ft
S2 – 3ft x 1.5ft
S3 – 3ft x 2ft
S4 – 4.5ft x 1ft
S5 – 4.5ft x 1.5ft
S6 – 4.5ft x 2ft
S7 – 6ft x 1ft
S8 – 6ft x 1.5ft
S9 – 6ft x 2ft

Root trimming

T1 – No root trimming
T2 – Root trimming

Treatment combinations

1) S1T1 – 3ft x 1ft + No root trimming
2) S2T1 – 3ft x 1.5ft + No root trimming
3) S3T1 – 3ft x 2ft + No root trimming
4) S4T1 – 4.5ft x 1ft + No root trimming
5) S5T1 – 4.5ft x 1.5ft + No root trimming
6) S6T1 – 4.5ft x 2ft + No root trimming
7) S7T1 – 6ft x 1ft + No root trimming
8) S8T1 – 6ft x 1.5ft + No root trimming
9) S9T1 – 6ft x 2ft + No root trimming
10) S1T2 – 3ft x 1ft + Root trimming
11) S2T2 – 3ft x 1.5ft + Root trimming
12) S3T2 – 3ft x 2ft + Root trimming
13) S4T2 – 4.5ft x 1ft + Root trimming
14) S5T2 – 4.5ft x 1.5ft + Root trimming
15) S6T2 – 4.5ft x 2ft + Root trimming
16) S7T2 – 6ft x 1ft + Root trimming
17) S8T2 – 6ft x 1.5ft + Root trimming
18) S9T2 – 6ft x 2ft + Root trimming

Yield and yield attributes

Number of shoots or branches

Numbers of shoots or branches per plant for each harvest were recorded from the sample plants and the average values were calculated.

Shoot length

Shoot lengths (cm) of shoots of the sample plants were recorded from cutting point to the tip of the shoot for each harvest and the mean shoot lengths were calculated.

Number of leaves per shoot

Numbers of leaves per shoot per plant for each harvest were recorded from the sample plants and the average values were calculated. In this case the compound leaves will be taken as one and only the opened leaves were counted.

Fresh weight of shoots

Fresh weights (g) of shoots from the sample plants were recorded for each harvest after draining out the excess moisture by keeping them in slanting position for one hour and the average values were calculated.

Total yield

The total yield was recorded finally by summing up all the harvests i.e. first to last harvest.

Results and Discussion

Number of shoots

The results of the present investigation showed that the number of harvestable shoots per plant of water mimosa as influenced by different spacings and root trimming methods was found highest in the treatment S_9T_2 with a value of 40.91 which is significantly higher than the remaining treatments with the exception of S_5T_2, S_6T_2, S_8T_1, S_8T_2 and S_9T_1 while the lowest was found in treatment S_1T_1 with a value of 15.24.

The difference between the highest and lowest is highly significant and this may due to optimum spacing and perhaps trimming of roots resulting in the formation of more functional new roots.

Higher number of tillers in rice when transplanted at optimum spacing was reported by Zhang *et al.,* (2014); Hasanuzzaman *et al.,* (2009) and Wang *et al.,* (2010) and similar findings were also opined in sugarcane crop by Jabran *et al.,* (2011) and Singh *et al.,* (2018).

Shoot length

A perusal of the data in Table 2 revealed significant difference in the shoot length of treatments S_1T_1 and S_8T_2. The maximum shoot length was found in treatment S_1T_1 with a value of 27.28 cm which was significantly higher than S_4T_2, S_8T_2 and S_9T_1 but not from the remaining treatments while the minimum shoot length was observed in treatment S_8T_2 with a value of 23.54 cm. The higher length was observed in closer spacing rather than wider spacing. Similar finding was reported by Siddiqui *et al.,* (2007) on cotton. It may be due to the competition among the shoots for more space and sunlight resulting in the elongation of shoots.

Number of leaves per shoot

In case of number of functional leaves per shoot, it has significantly high difference between the treatments S_1T_2 and S_2T_2. The highest number of leaves was found in treatment S_2T_2 with a value of 20.90 which was significantly higher than the treatments S_1T_1, S_1T_2, S_2T_1, S_4T_2, S_5T_1, S_6T_1 and S_8T_1 but not from the remaining treatments. The lowest was found in treatment S_1T_2 with a value of 17.00. It seems to have more number of leaves in closer spacing than the wider spacing. It may be due to closer spacing allows the accumulation of nod-gene inducing factors (e.g. Flavanoids – plant produce) and nodule inducing factor (e.g. Lipochitin oligosaccharides) which helps in development of leaves. This was supported by the work of James *et al.,* (1993) in *Neptunia plena*.

Fresh weight of shoots

Between the highest and lowest values of fresh weight, the difference is highly significant. The highest value of fresh weight was found in S_9T_2 with a value of 1204 g which was significantly higher than the remaining treatments with the exception of S_9T_1, S_8T_1, S_8T_2, S_6T_1 and S_6T_2 while lowest was found in S_1T_1 with a value of 444 g.

In the present investigation, the earlier harvested shoots have heavier weight than the shoots harvested in later stages of the crop growth. It seems to have more weight in wider spacing of root trimming than the closer spacing. Similar findings were reported in lettuce by Uddain *et al.,* (2017) and in okra by Madisa *et al.,* (2015).

Total yield

Interaction between spacing and root trimming has significant influence on the total yield of shoots. Root trimming did not bring any significant effect. Among the treatment combinations, the maximum value was observed in treatment S_5T_2(4.5ft x 1.5ft with root trimming) with a value of 10149 Kg/ha which was significantly higher than the remaining treatments with the exception of treatment S_5T_1(4.5ft x 1.5ft without root trimming) i.e. 10048 Kg/ha and followed by S_4T_2 (9526 Kg/ha) and S_4T_1 (9439 Kg/ha) while the lowest was observed in S_9T_1 with a value of 5906 Kg/ha. Higher yield was observed in treatment combination with optimum spacing. Same was reported in groundnut by Gadade *et al.,* (2018). It may be due to accumulation of nod-gene inducing factors (e.g. Flavanoids – plant produce) and nodule inducing factor (e.g. Lipochitin oligosaccharides) produced from the trimming of roots and the optimum spacing allowed them to spread and accumulate uniformly to the water mimosa which lead to the production of more yield. This was supported by the work of James *et al.,* (1993) in *Neptunia plena*.

Table.1 Number of shoots as influenced by different spacing and root trimming of water mimosa

SxT	S_1	S_2	S_3	S_4	S_5	S_6	S_7	S_8	S_9	Mean
T_1	15.24	24.00	26.47	24.24	38.33	39.14	25.71	39.43	40.09	**30.30**
T_2	16.76	24.81	27.52	25.29	40.05	40.62	28.38	40.43	40.91	**31.64**
Mean	**16.00**	**24.40**	**27.00**	**24.76**	**39.19**	**39.88**	**27.05**	**39.93**	**40.50**	

	S	T	SxT
SE d (±)	0.60	0.28	0.84
CD (P=0.05)	1.21	0.57	NS
C.V (%)	**3.34**		

Table.2 Mean Shoot Length (cm) as influenced by different spacing and root trimming of water mimosa

SxT	S_1	S_2	S_3	S_4	S_5	S_6	S_7	S_8	S_9	Mean
T_1	27.28	26.21	26.34	25.89	25.78	26.30	24.85	24.56	23.56	**25.64**
T_2	26.93	26.29	26.80	24.21	25.83	25.74	26.75	23.54	24.94	**25.67**
Mean	**27.10**	**26.25**	**26.57**	**25.05**	**25.81**	**26.02**	**25.80**	**24.05**	**24.25**	

	S	T	SxT
SE d (±)	0.98	0.46	1.38
CD (P=0.05)	1.99	NS	NS
C.V (%)	**6.61**		

Table.3 Number of leaves per shoot as influenced by different spacing and root trimming of water mimosa

SxT	S_1	S_2	S_3	S_4	S_5	S_6	S_7	S_8	S_9	Mean
T_1	18.57	18.10	20.43	20.10	18.76	18.24	19.10	18.19	19.57	**19.01**
T_2	17.00	20.90	20.29	19.24	18.86	19.95	18.95	20.38	19.48	**19.45**
Mean	**17.79**	**19.50**	**20.36**	**19.67**	**18.81**	**19.09**	**19.02**	**19.29**	**19.52**	

	S	T	SxT
SE d (±)	0.74	0.35	1.05
CD (P=0.05)	1.50	NS	2.12
C.V (%)	**6.65**		

Table.4 Fresh weight (g) as influenced by different spacing root trimming of water mimosa

SxT	S_1	S_2	S_3	S_4	S_5	S_6	S_7	S_8	S_9	Mean
T_1	444	723	794	724	1152	1180	775	1185	1197	**908**
T_2	453	704	788	730	1167	1191	812	1185	1204	**915**
Mean	**448**	**714**	**791**	**727**	**1160**	**1186**	**794**	**1185**	**1200**	

	S	T	SxT
SE d (±)	10.32	4.86	14.59
CD (P=0.05)	20.94	NS	29.61
C.V (%)	**1.96**		

Table.5 Yield (Kg/ha) of shoots for one hectare as influenced by different spacing and root trimming of water mimosa

SxT	S_1	S_2	S_3	S_4	S_5	S_6	S_7	S_8	S_9	Mean
T_1	8689	9426	7763	9439	10048	7697	7584	7727	5906	**8250**
T_2	8857	9185	7707	9526	10149	7768	7943	7727	5940	**8311**
Mean	**8773**	**9306**	**7735**	**9482**	**10098**	**7732**	**7763**	**7727**	**5923**	

	S	T	SxT
SE d (±)	99	47	140
CD (P=0.05)	201	NS	285
C.V (%)	2.07		

Figure.1 Number of shoots as influenced by different spacing and root trimming of water mimosa

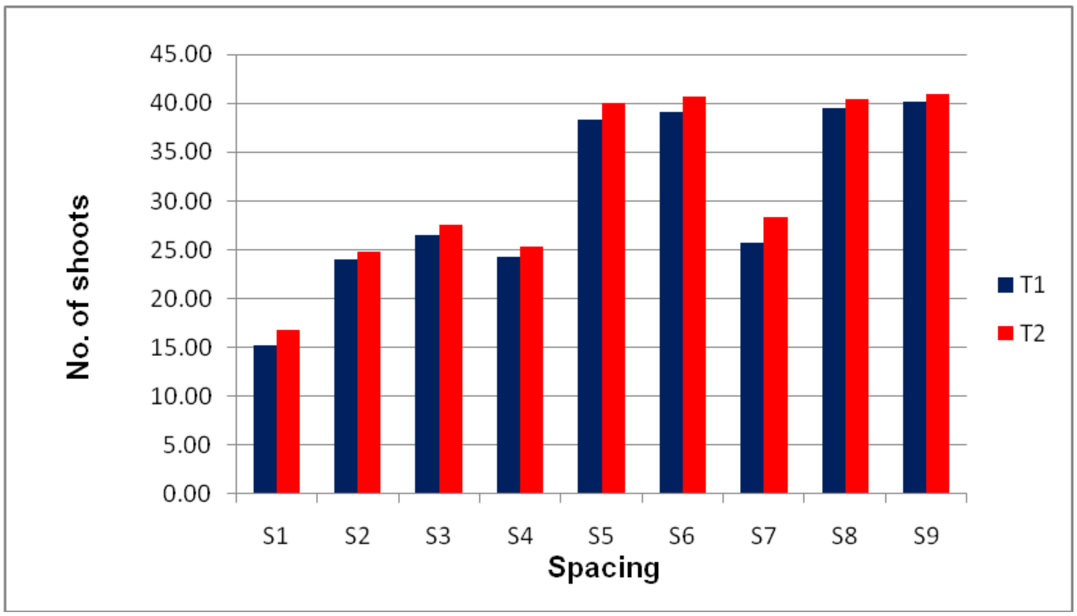


Figure.2 Mean Shoot Length (cm) as influenced by different spacing and root trimming of water mimosa

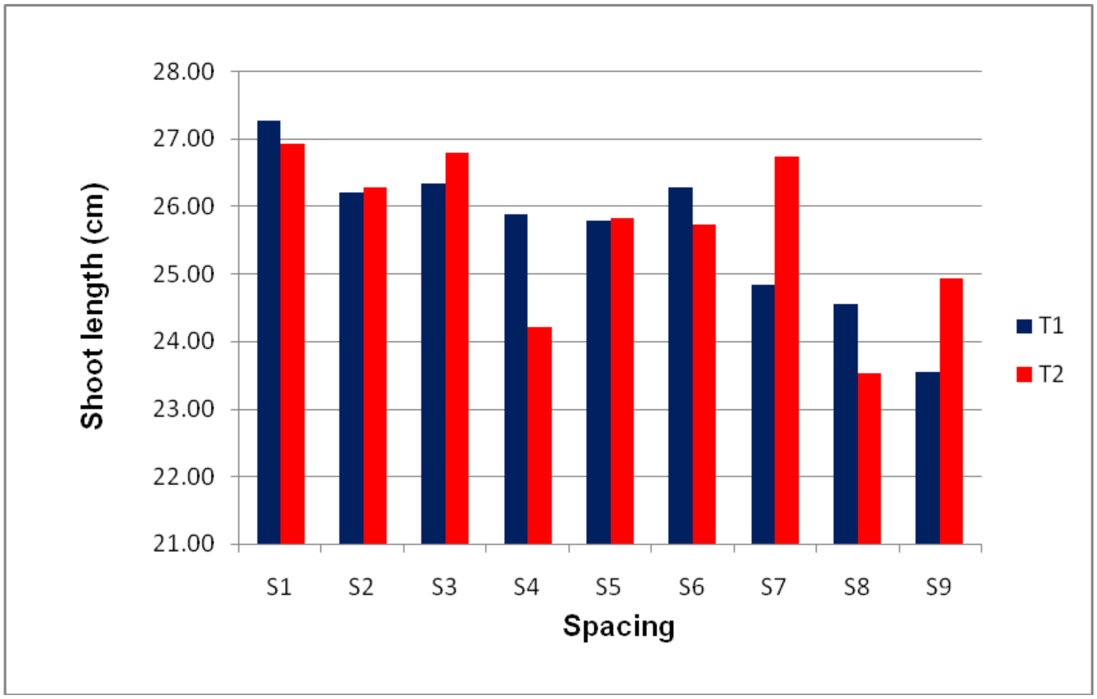


Figure.3 Number of leaves per shoot as influenced by different spacing and root trimming of water mimosa

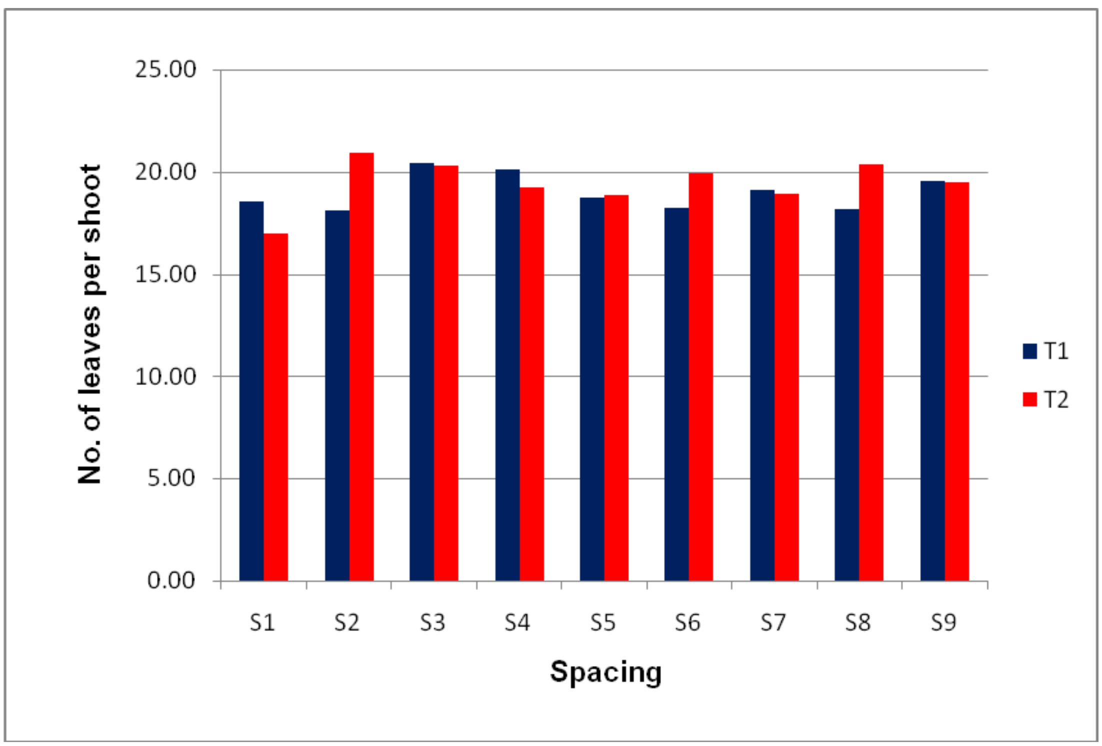


Figure.4 Fresh weight (g) as influenced by different spacing root trimming of water mimosa

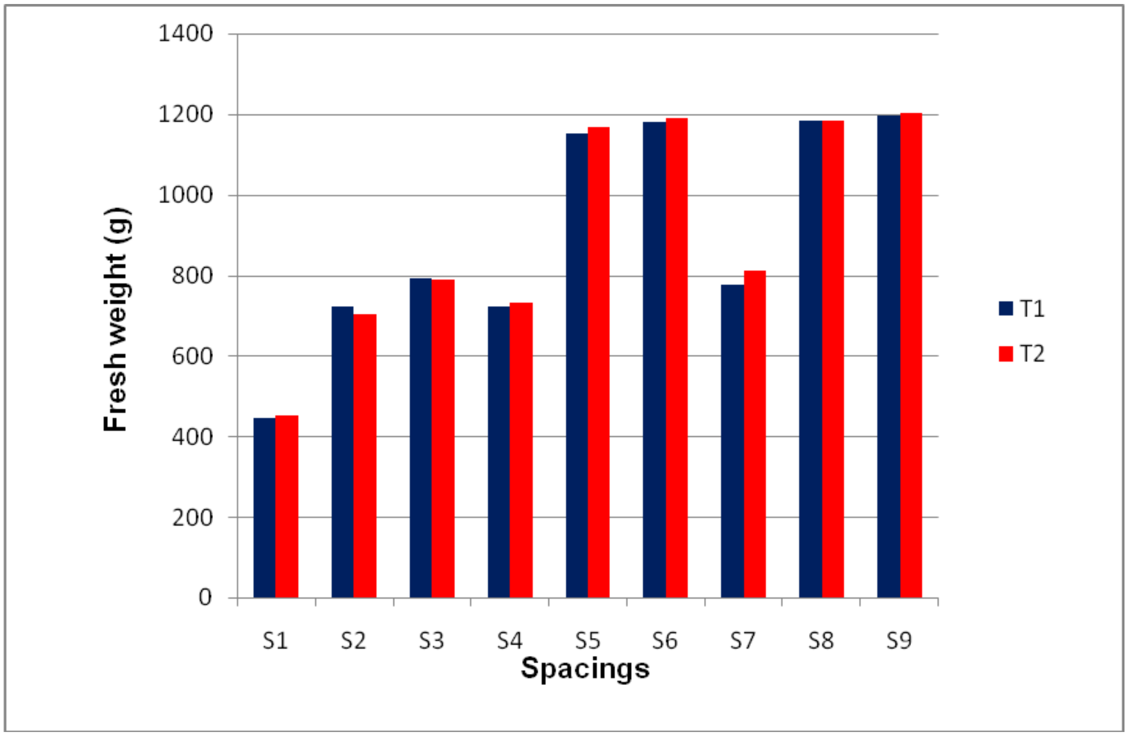
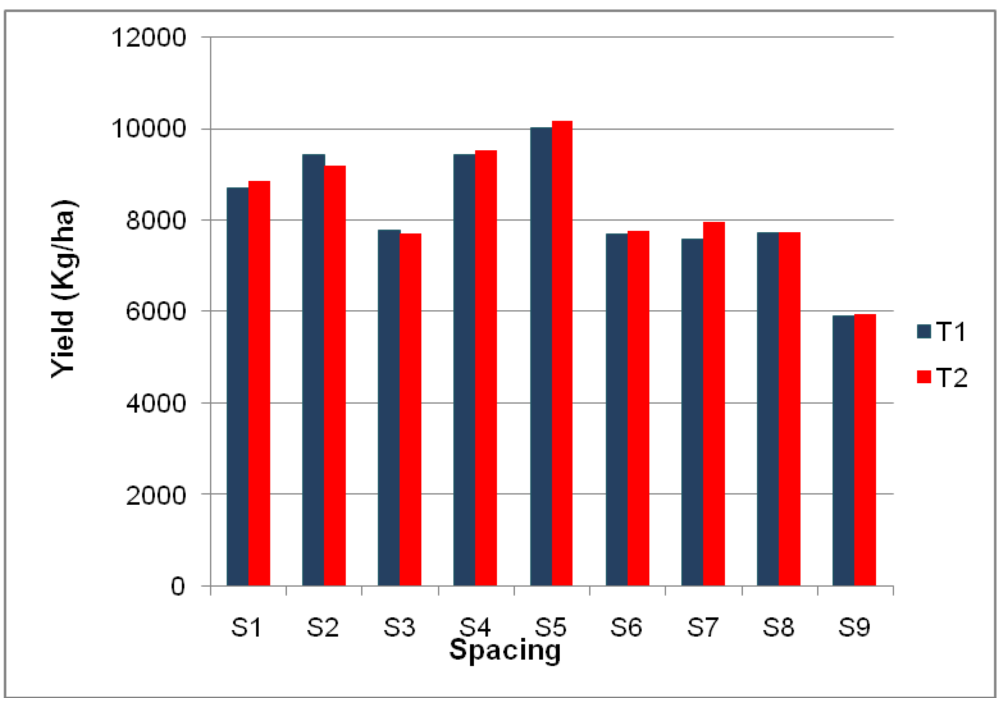


Figure.5 Yield (Kg/ha) of shoots for one hectare as influenced by different spacing and root trimming of water mimosa



Based upon the results obtained, it can be concluded that treatments S_5T_2 (4.5ft x 1.5ft, root trimming) and S_5T_1 (4.5ft x 1.5ft, without root trimming) have the highest benefit cost ratio in comparison to other treatments because of optimum occupancy of area or space. Therefore, the treatments S_5T_2 (4.5ft x 1.5ft, root trimming) and S_5T_1 (4.5ft x 1.5ft, without root trimming) maybe recommended for growing water mimosa extensively in Manipur to maximise the production of water mimosa. As these results were obtained from only one year or one season data, further investigation is suggested, basing on which it can be recommended for the farmers and other end users.

Author Contributions

Mutum Dinamani: Investigation, formal analysis, writing—original draft. L. Nabachandra Singh: Validation, methodology, writing—reviewing. N. Devachandra Singh:—Formal analysis, writing—review and editing. N. Okendro Singh: Investigation, writing—reviewing. M. Dinachandra Singh: Resources, investigation writing—reviewing.

Data Availability

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethical Approval Not applicable.

Consent to Participate Not applicable.

Consent to Publish Not applicable.

Conflict of Interest The authors declare no competing interests.

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