Asian Journal of Advances in Agricultural Research

Volume 24, Issue 3, Page 5-9, 2024; Article no.AJAAR.113040
ISSN: 2456-8864

Impact of NPK on the Ecophysiological Attributes of *Thespesia populnea*

R. Jude Sudhagar [a++], C. Cinthia Fernandaz [b#*], S. Vennila [c†], S. Manivasakan [b‡] and Th. S. Robin [d^]

[a] DARS, Chettinad, TNAU, India.
[b] ICAR-KVK-The Nilgiris, TNAU, India.
[c] AC and RI, Thiruvannamalai, TNAU, India.
[d] TNAU, India.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI:10.9734/AJAAR/2024/v24i3493

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/113040

Original Research Article

Received: 24/12/2023
Accepted: 27/02/2024
Published: 06/03/2024

ABSTRACT

A field experiment was conducted to investigate the effect of different levels of NPK on the performance of *Thespesia populnea*. A total of 17 treatments consisted of four levels of Nitrogen (50, 75, 100 and 125 g N plant-1), two levels each of Phosphorus (50 and 75 g P plant-1), and Potassium (25 and 50 g K plant-1) were tried in RBD replicated three times, to standardize the fertilizer schedule for the tree crop taken for investigation. The experimental soil was red sandy loam, non-calcareous, neutral in reaction, low in available nitrogen, phosphorus and medium in available potassium with low organic carbon content. Ecophysiological parameters viz., photosynthestic rate (A), transpiration rate (E), stomatal conductance (gs) and Intercellular CO2

[++]Professor (Forestry);
[#]Associate Professor (Agrl. Extension);
[†]Assistant Professor (Forestry);
[‡]Associate Professor (Forestry);
[^] Research Scholar;
**Corresponding author: Email: cinthiafernandaz.c@tnau.ac.in;*

concentration (CINT). Growth attributes were influenced by N, P and K at different levels. Among the various treatments application of 100 : 75 : 50 g NPK plant-1 (T12) significantly influenced the growth attributes followed by 100 : 75 : 25 g NPK plant-1 (T11).

Keywords: Ecophysiological attributes; Thespesia; randomized block design; transpiration rate; stomatal conductance; intercellular CO2 concentration.

1. INTRODUCTION

Forests are not just trees, but part of an ecosystem that interlinks life, economics and societies. Forest provides a multiplicity of environmental services [1]. As per Indian State of Forest Report (ISFR) 2013, "the forest cover of the country is 6,97,898 sq.km. (69.79 million ha) which is 21.23 per cent of the geographical area of the country while the tree cover of the country is estimated to be 91,266 sq.km. (9.13 million ha) which is 2.78 per cent of the geographical area. The total forest and tree cover of the country as per 2013 assessment is 7,89,164 sq.km. (78.92 million ha) which is 24.01 per cent of the geographical area of the country. There is an increase of 5,871 sq. km. in the forest and tree cover of the country in comparison to 2011 assessment. The total growing stock of India's forest and trees outside forest is estimated as 5,658.046 million m^3 which comprises 4,173.362 million m^3 inside the forests and 1,484.68 million m^3 outside the forests. India is home to 17 per cent of world human population and 18 per cent of livestock population which causes severe pressure to the Indian forests. Nearly 40 per cent of domestic fuel needs of people and 30 per cent of fodder needs for cattle population in the country are met from forests [2]. The demand and supply gap of timber, fuelwood and fodder is widening whereas the raw material requirement of wood based industries is on the raise". The National Forest Policy (1988) suggested that "the wood based industries will have to make their own arrangements for the supply of raw materials. Besides this, most of the Government policies and acts stress mostly on the conservation of existing natural vegetation. Hence, the importance of industrial plantations has gained momentum across the country to meet out the industrial raw material needs. In order to fulfill the domestic and industrial demands of wood, the only viable option is to increase the area under agroforestry and industrial plantations [3]. The role of indigenous species and fast growing species in this regard need not be overemphasized as selection of suitable tree species plays a major role in the success of agroforestry. *Thespesia populnea* is one such indigenous tree species which has multiple uses".

Thespesia populnea is a fast growing evergreen tree belonging to the family Malvaceae which is commonly known as Tulip tree or Portia tree and it is called as Puvarasu in Tamil. *Thespesia populnea* is a small to medium-sized evergreen tree of the coastal tracts of India and Myanmar which grows upto 20 m with a dense crown. It is widely planted as a roadside tree in tropical regions and recognized by its large yellow flowers with purple centres. The flowers open and close on the same day, and the yellow flowers turn dark red, purple or pink as the day progresses. Bark is dark brown, rough, deeply cracked, fissured and slash yellow coloured. It prefers neutral soils with pH 6.0-7.4 and thrives well on sandy coastal soils, but also grows on volcanic soils, soils derived from limestone and rocky headlands. It does not do well on upland, acidic clays. It is very tolerant to salt spray, steady coastal winds and highly resistant to dry wood termites. It tolerates heavier soils, soil salinity and occasional inundation, but does not grow on permanently inundated soils. In order to obtain robust and healthy plantations, proper fertilizer management is essential under field conditions. Lack of studies in this aspect necessitated the present investigation to study the Impact of NPK on the Ecophysiological attributes of the species

2. MATERIALS AND METHODS

The present study was conducted in order to standardize the fertilizer requirement for *Thespesia populnea* (L.) Selex Correa**.** With the view of fulfilling the objectives envisaged, experiments were carried out at Forest College and Research Institute, Mettupalayam, Tamil Nadu during 2014-2015.

The materials used and the methods followed during the course of investigation are furnished in this chapter.

2.1 Materials

2.1.1 Species under study- *Thespesia populnea*

i) Species description

Species : *Thespesiapopulnea*
Family : Malvaceae
Tamil name : Poovarasu
Common name: Indian Tulip Tree, Portia tree, Pacific Rosewood
Trade name: Seychelles Rose wood

2.1.2 Assessment of eco-physiological behavior

Ecophysiological characters were assessed by using a Portable Photosynthesis System (PPS, model LCpro + Photosynthesis System CO_2 gas analyzer, UK) to assess the eco-physiological behaviour of selected tree species. The measurements were made on fully matured leaves (5-6 leaves from the bud) Adalarasan [4]. The ecophysiological parameters *viz*., transpiration rate, stomatal conductance, Intercellular CO_2 Concentration (CINT) and photosynthetic rate were measured on a sunny day between 10.00 AM and 11.00 AM as per the procedure described below [5].

2.1.3 Photosynthetic rate (A)

The photosynthetic rate of trees was measured using the Portable Photosynthesis System (PPS, model LCpro + Photosynthesis System CO_2 gas analyzer, UK)[6]. The PPS measures the uptake of CO_2 and estimates the photosynthetic productivity using Infra-Red Gas analyzer (IRGA) and expressed in µ mol m^{-2} s^{-1}.

2.1.4 Transpiration rate (E)

The transpiration rate was measured using Portable Photosynthesis System (PPS, model LCpro$^+$ Photosynthesis System Co_2 gas analyzer, UK) and expressed as m mol m^{-2} s^{-1}.

2.1.5 Stomatal conductance (gs)

Stomatal conductance was measured using the Portable Photosynthesis System (PPS, model LCpro + Photosynthesis System CO_2 gas analyzer, UK) and expressed in m mol m^{-2} s^{-1} [7].

2.1.6 Intercellular Co_2 Concentration (CINT)

Intercellular Co_2 concentration measures the photosynthetic efficiency of plant. It was measured using Portable Photosynthesis System (PPS, model LCpro + Photosynthesis System CO_2 gas analyzer, UK) and expressed in ppm.

3. RESULTS AND DISCUSSION

3.1 Ecophysiological Attributes

Portable Photosynthesis System (LC Pro $^+$) was used to observe changes in ecophysiological behaviour of *Thespesia populnea* and four parameters *viz.,* photosynthetic rate (A), transpiration rate (E), stomatal conductance (g_s) and inter cellular Co_2 (CINT) were recorded and tabulated in Table 1.

3.2 Photosynthestic Rate (A)

Photosynthetic rate which is a measure of productive potential of a tree was measured and the results are presented in the Table 1. During 6 MAP, the application of 100:75:50 g NPK $plant^{-1}$ (T_{12}) recorded the highest photosynthetic rate of 15.19 µ mol m^{-2} s^{-1} followed by the application of 125:75:50 g NPK $plant^{-1}$ (T_{16}) which recorded 15.10 µ mol m^{-2} s^{-1} whereas the treatment T_{17} which did not receive any fertilizers registered the lowest photosynthetic rate of 9.45 µ mol m^{-2} s^{-1} [8].

3.3 Transpiration rate (E)

The transpiration rate exhibited significant variation among the different treatments imposed (Table 1). At 6 MAP, the highest transpiration rate of 7.26 m mol m^{-2} s^{-1} was observed due to application of 100:75:50 g NPK $plant^{-1}$ (T_{12})followed by the application of 125:75:50 g NPK $plant^{-1}$ (T_{16}) and 100:75:25 g NPK $plant^{-1}$(T_{11}) with the values of 7.04 and 6.96 m mol m^{-2} s^{-1} respectively [9]. The lowest transpiration rate of 3.62 m mol m^{-2} s^{-1} was registered where no fertilizer were imposed.

3.4 Stomatal Conductance (gs)

Stomatal conductance recorded significant variation among the various treatments and the results are presented in Table 1. During 6 MAP, the highest stomatal conductance of 0.24 m mol m^{-2} s^{-1} was reported due to application of 100:75:50 g NPK $plant^{-1}$ (T_{12}) followed by the application of 125:75:50 g NPK $plant^{-1}$ (T_{16}) and 100:75:25 g NPK $plant^{-1}$ (T_{11}) with the values of0.22 and 0.21 m mol m^{-2} s^{-1}respectively [10]. The treatment T_{17}recorded the lowest stomatal conductance of 0.10 m mol m^{-2} s^{-1} where no nutrients were applied.

Table 1. Influence of NPK on the ecophysiologicalbehaviour of *Thespesia populnea* at 6 MAP

Treatments	Photosynthetic rate (μ mol m^{-2} s^{-1})	Transpiration rate (m mol m^{-2} s^{-1})	Stomatal conductance (m mol m^{-2} s^{-1})	Inter Cellular CO_2 Concentration (ppm)
T_1 -50:50:25 g NPK $plant^{-1}$	9.94	3.82	0.11	175
T_2 -50:50:50 g NPK $plant^{-1}$	10.67	3.84	0.12	178
T_3-50:75:25 g NPK $plant^{-1}$	11.62	4.42	0.12	188
T_4 -50:75:50 g NPK $plant^{-1}$	11.86	4.83	0.13	190
T_5 -75:50:25 g NPK $plant^{-1}$	12.27	5.06	0.14	198
T_6 -75:50:50 g NPK $plant^{-1}$	12.63	5.35	0.14	205
T_7 -75:75:25 g NPK $plant^{-1}$	12.93	5.53	0.15	208
T_8 -75:75:50 g NPK $plant^{-1}$	12.95	5.61	0.15	214
T_9 -100:50:25 g NPK $plant^{-1}$	13.14	6.15	0.16	218
T_{10} -100:50:50 g NPK $plant^{-1}$	13.21	6.22	0.16	225
T_{11} -100:75:25 g NPK $plant^{-1}$	14.13	6.96	0.21	256
T_{12} -100:75:50 g NPK $plant^{-1}$	15.19	7.26	0.24	263
T_{13} -125:50:25 g NPK $plant^{-1}$	13.54	6.41	0.17	232
T_{14} -125:50:50 g NPK $plant^{-1}$	13.68	6.50	0.18	245
T_{15} -125:75:25 g NPK $plant^{-1}$	13.69	6.56	0.19	250
T_{16} -125:75:50g NPK $plant^{-1}$	15.10	7.04	0.22	259
T_{17}-Absolute control	9.45	3.62	0.10	167
SEd	1.78	0.20	0.01	1.32
CD(P=0.05)	3.61	0.42	0.03	2.68

3.5 Inter Cellular CO_2 Concentration (CINT)

Among the different treatments, the maximum inter cellularCO_2 concentration (CINT) of 263 ppm was observed in T_{12} followed by T_{16} and T_{11} with the values of 259 and 256 ppm whereas the treatment T_{17} which did not receive any fertilizers registered lowest inter cellular CO_2 concentration (CINT) of 167 ppm [11].

3.6 Ecophysiological Attributes

The ecophysiological behaviour of plants plays a vital role in the growth of plants and are important factors for changing environmental conditions [12]. The influence of different levels of nutrients on the parameters *viz.,* photosynthestic rate (A), transpiration rate (E), stomatal conductance (g_s) and Intercellular CO_2 concentration (CINT) are discussed.

4. SUMMARY AND CONCLUSION

Nutrient management is one of the prime factors which plays a vital role in the growth, development and successful completion of life cycle in crop plants. Judicious integration of organic and inorganic fertilizers has been proved to be a viable and economically feasible technology for enhancing the initial growth and development of plants. Growth components *viz.,* plant height, collar diameter, volume index and biomass yield were recorded. Growth analysis was done by estimating LAI and ecophysiological parameters *viz.,* photosynthestic rate (A), transpiration rate (E), stomatal conductance (g_s) and Intercellular CO_2 concentration (CINT) were also recorded. The growth attributes were influenced by N, P and K at different levels. Among N, P and K levels, application of 100: 75: 50 g NPK $plant^{-1}$ (T_{12}) significantly influenced the growth attributes followed by 100: 75: 25 g NPK $plant^{-1}$ (T_{11}).

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. FAO. State of the World's Forests- Forest pathways to sustainable developments. Rome, Italy; 2018.
2. Rao PB. Effect of shade on seedling growth of five important tree species in Tarai region of Uttaranchal. Bulletin of the National Institute of Ecology. 2005;15:161-170.
3. Baranidharan K, Vijayabhama M, Suresh KK. Intensive silvicultural packages for Casuarina species. Lap Lambert, Academic Publishing, Germany. 2013; 292.
4. Adalarasan R. Carbon sequestration potential of teak (*Tectona grandis*) as influenced by fertilization and irrigation. Ph.D. Thesis, Tamil Nadu Agricultural University, Coimbatore, India; 2008.
5. Gikloo, Samandari, Behnam Elhami. Physiological and morphological responses of two almond cultivars to drought stress and cyclone. International Research Journal of Applied and Basic Sciences. 2012;3(5):1000-1004.
6. Okuto JL, Ouma G. Provenance variation of photosynthesis of seedlings of java plum (*S. cuminii*) in Western Kenya. Agriculture and Biology Journal of North America. 2010;(6):1260-1263.
7. Esser Gerd. Stomatal response of some trees and shrubs from various tropical environments to variable CO_2 concentrations. Tropical Ecology. 2004; 45(1):113-121.
8. Ladjal Mehdi, Nathalie Deloche, Roland Hucand Michel Ducrey.Effects of soil and air drought on growth, plant water status and leaf gas exchange in three Mediterranean cedar species: *Cedrusatlantica, C. brevifolia* and *C. libani*. Trees - Structure and Function. 2007; 21(2):201-215.
9. Narendra Babu S. Quantifying carbon sequestration potential in fast growing trees through afforestation. M.Sc. Thesis, Tamil Nadu Agricultural University, Coimbatore; 2012.
10. Rewald et al. Woody plants and forest ecosystems in a complex world- ecological interactions and physiological functioning above and below ground. Front. Plant Science; 2020. DOI:10.3389/fpls.2020-00173
11. Dinesh Kumar and N. Ahmed. Response of nitrogen and potassium fertigation to 'Waris' almond (*Prunus dulcis*) under north western Himalayan region of India. Indian J. Agric. Sci. 2010;80:512-516.
12. Yang liu, Songheng Jin and Guolei Li. Physiological ecology of trees under environmental stresses. Front. Pl. Sci. 2023;14 DOI.103389/fpls2023.1158821

Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/113040