Indian Journal of Ecology (2024) 51(3): 521-524
DOI: https://doi.org/10.55362/IJE/2024/4266

Manuscript Number: 4266
NAAS Rating: 5.38

Influence of Bund Planted Teak (*Tectona grandis* L. f.) Trees on Field Crops in Semi-Arid Tropics

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***Abstract*:** Field experiment was conducted to observe the influence of bund planted teak trees on field crops during 2021-22 in Agroclimatic Zone-2 (North-Eastern Dry Zone) of Karnataka, India. Treatment consists three distances from tree 2-6 m, 6-10 m 10-14 m and subplots three crops greengram, blackgram and pigeon pea. Significantly lower yield attributing characters such as plant height, number of branches per plant and number of pods per plant of green gram, pigeon pea and black gram respectively were recorded near the tree line at 2-6 m and were increased with increase in distance from the tree line and at distance to 10-14 m and were on par with the control (without trees). However, significantly lower grain yield of green gram and pigeon pea (456 kg ha^{-1} and 1166 kg ha^{-1} respectively) were near tree line and were increased with increase in distance from tree line and at distance 10-14 m grain yields of green gram and pigeon pea were on par with the control (without trees). Grain yield of black gram did not differ significantly over distances from tree line but numerically lower grain yield of black gram was noticed near tree line. The pooled average reduction in yield of green gram, pigeon pea and black gram were 16, 9 and 2 per cent respectively as compared to control. The significantly higher soil organic carbon content, available N, P_2O_5 and K_2O (0.42%, 382, 38 and 413 kg ha^{-1}, respectively) were near the tree line and were decreased with increase in distance from the tree line and at distance 10-14 m parameters were on par with control. In all the negative and positive influence on associated crops and soil properties respectively were extended up to 10 m distance from the tree line and among the crops black gram was least affected followed by pigeon pea and green gram.

***Keywords*:** Teak, Bund planting, Influence, Field crop and pigeon pea

Farmers are showing keen interest in growing economical tree species in association with agriculture crops in the form of bund and boundary planting and in some instances as wood lots (block plantations) with an intension to get good returns in long run (Doddabasawa et al 2020). Further, growing of trees are influenced by heterogeneous factors like socio-economic condition of the farmer, ecological condition of the area, competitive and complementary effects of trees and more importantly utility and economic value of the species (Giller et al 2006). Among few economical tree species, teak (*Tectona grandis* L. f.) is widely grown by the farmers especially in southern part of India. Similarly, farmers have grown *Alnus nepalensis* in Himalayan region of India (Rita et al 2007), *Prosopis cineraria* with millets in Rajasthan (Tejwan 1994) and *Populus deltoids* with wheat in Western India (Chaun et al 2015) and farmers preferable interested to grow high valued timbers (Nyaga et al 2015).

Teak wood is durable and most admired and precious tree used widely from furniture to interior architecture and therefore teak tree is being listed as top priority species in more than 20 countries and is being grown over 70 countries (Walter and Michael 2017). Teak being mesic-deciduous species having thin crown with little spread and deep root system are considered to be most suitable species for small holding farmer (Pinyarat et al 2021). However, growing trees on bunds have both complimentary and competitive effects particularly on field crops and soil in general (Chittapur et al 2017). Further, response of field crops also varies. Thus, understanding the tree crop interaction is necessary to take up management strategies such pruning, thinning, crop selection and other practices. Hence, the present investigation was undertaken to know the influence of bund planted teak trees on pulse crops such as green gram, pigeon pea and black gram and as well as on soil chemical properties in North-Eastern Dry Zone of Karnataka.

MATERIAL AND METHODS

The study was under taken during 2021-22 in Yadgir district of North eastern dry zone (Zone II) of Karnataka at Agricultural Research Station, Bheemarayanagudi. The climate of the region is dry semi-arid with cool winters and dry hot summers. The average rainfall is around 750 mm and mean annual temperatures range from 18.6 to 32.5^{o}C and mean elevation ranges from 350-680 m. The soils are deep to very deep black soils and medium black soils in major areas

while sandy loam and light textured soils are also found in some pockets. However, the soil of the study site was medium black cotton soils The three pulse crops viz., green gram, black gram and pigeon pea were chosen for the experiment and were grown under rainfed conditions. The experiment was laid out in gross plot size 5.4 m X 5.0 m and net plot size 3.6 m X 4.0 m and sample plots were laid out randomly with 3 replications at distance of 2-6m, 6-10 m and 10-14 m, respectively from the tree line and total plots laid were nine for each crop, whereas in control (sole crop) three plots were laid out randomly in the entire field for each crop. The crops green gram (cv. BGS9), black gram (cv. TAU1) and pigeon pea (cv.TS3R) were sown during *kharif* 2021-22 with spacing of 30X10 cm, 30X10 cm and 90X10 cm respectively. Productivity of field crops such as plant height, number of branches per plant, number of pods per plant and grain yield were recorded with a net plot and the mature crop was harvested at ground level, later grain and haulm were separated. Further, they were dried and weighed and were computed, averaged and extrapolated to per ha basis. The teak trees were planted on bund in North- South direction with 45 trees running at a length of 100 m and the trees were of 12 years old with an average height of 8.58 m and average girth of 62.80 cm. However, crops were sown on the western direction of tree line. For soil chemical properties, the composite soil samples from 0-15 depths at 2 to 6.0, 6.0 to 10.0 and 10.0 to 14.0 m distance from the base of the tree towards western directions of the tree line were collected after harvest of crop from each plot for the estimation organic carbon (%) and available nitrogen (N), phosphorus (P_2O_5) and potassium (K_2O) (kg ha^{-1}). At the same time, soil samples were also collected from sole crop (without trees) for comparison of the nutrient status. The data was analyzed using Duncan test at significance level of 0.05 by using SPSS (Statistical Package for Social Science) version 20.0.

RESULTS AND DISCUSSION

The investigation on the influence of bund planted teak (*Tectona grandis* L. f) trees on greengram, blackgram and pigeon pea at different distances from tree line on western direction revealed significant differences. Significantly lower plant height of greengram, blackgram and pigeonpea (40.60, 44.20 and 96.20 cm respectively) were near tree line at distance of 2-6 m and were increased with increase in distance from tree line and at distance 10-14 m and were on par with control (without trees). The significantly lower number of branches per plant of pigeon (4.80 plant $^{-1}$) were near the tree line. The number of branches per plant of green gram and black gram did not differ significantly. The significantly lower number of pods per plant of green gram and pigeon pea (11.20 and 75.60 plant $^{-1}$respectively) were near the tree line at distance 2-6m whereas in black gram number of pods per plant did not differ significantly. The lower plant growth attributes near the tree could be due to the competitive effect of trees for light, moisture and nutrients with field crops. However, among the crops black gram was

Table 1. Methodologies used for analysis of soil chemical properties

Parameters	Methodology	Reference
pH	1:2.5 soil water suspension with the help of digital pH meter	Jackson (1973)
EC (dS m^{-1})	1:2.5 soil water suspension using conductivity bridge	Jackson (1973)
OC (%)	Walkley and Black rapid titration method	Walkley and Black (1934)
Available N (kg ha^{-1})	Alkaline potassium permanganate method	Subbaiah and Asija (1956)
Available P_2O_5 (kg ha^{-1})	Spectrophotometric method (Olsen Extraction Method with 0.5 M $NaHCO_3$, pH of 8.5)	Jackson (1973)
Available K_2O (kg ha^{-1})	Flame-Photometric method (Extraction with NH_4OAC of pH 7)	Jackson (1973)

Table 2. Influence of bund planted teak (*Tectona grandis* L. f.) trees on yield attributing characteristics of green gram (*Vigna radiata*), black gram (*Vigna Mungo*) and pigeon pea (*Cajanus cajan*) at different distances from tree line

Treatment	Plant height (cm)	No. of branches/plant	No. of pods/plant	Plant height (cm)	No. of branches/plant	No. of pods/plant	Plant height (cm)	No. of branches/plant	No. of pods/plant
Field crops	Green gam			Black gram			Pigeon pea		
D_1 (2-6m)	40.60^{a}	2.20^{a}	11.20^{a}	44.20^{a}	3.60^{a}	24.20^{a}	96.20^{a}	4.80^{a}	75.60^{a}
D_2 (6-10m)	52.20^{b}	3.20^{b}	17.40^{b}	48.00^{b}	4.00^{b}	27.60^{abc}	109.40^{b}	6.00^{ab}	96.40^{b}
D_3 (10-14m)	59.20^{c}	3.40^{b}	24.00^{c}	52.80^{c}	4.40^{b}	28.80^{abc}	127.80^{c}	7.20^{b}	104.80^{b}
Control (without trees)	58.60^{c}	3.40^{b}	25.00^{c}	55.20^{c}	4.60^{b}	31.00^{c}	129.40^{c}	7.40^{b}	105.40^{b}

least affected with respect to the number of branches per plant and number of pods per plant could be due to black gram plant grows quite erect and hairy structure on leaf and pods might have contributed to with stand moisture scarcity. The grain yield was significantly lower in green gram and pigeon pea (456 kg ha^{-1} and 1166 kg ha^{-1}respectively) near tree line at distance 2-6m and were increased with increase in distance and at distance 10-14m grain yield were on par with the control (without trees). Grain yield of black gram was non-significant. The lower grain yield of green gram and pigeon pea near the tree line could be due to shading and competitive effect of trees for light, moisture and nutrients. Among the crops black gram was least affected as compared to the pigeon pea followed by green gram. This could be due physiological characteristics of black gram which has erect growing, hairy structures on leaves and pods and deep root system as compared to pigeon pea and green gram and as well as higher number of branches and pods per plant of black gram might have contributed to higher grain yield (Nanadal and Singh 2001). The pooled yield over distances as compared to the control (without trees) indicated reduction of grain yield of green gram, pigeon pea and black gram by 16, 9 and 2 per cent respectively. However, significantly higher percent yield reductions of green gram, pigeon pea and black gram (36, 20 and 10 per cent respectively) were near the tree line at distance of 2-6m as compared at other distances as compared to control (without trees). This could be more shade near the tree line and among the crop higher reduction was observed in green gram followed by pigeon pea whereas least reduction was observed in black gram (Patil and Channabasappa, 2008) Thus, black gram is most suitable crop followed by pigeon pea and green gram. Further, green gram is seems to be more sensitive to shade as compared to pigeon pea and black gram.

The influence of bund planted teak (*Tectona grandis*L. f) trees on soil chemical properties at different distances revealed that soil pH and EC did not differ significantly with respect to distances. Further, numerically lower soil pH and EC were recorded near tree line and increased with increase in distance from the tree line and were on par with the control (without trees) (Table 4). This indicates that trees did influence much on these properties as the trees are of 12 years old. Significantly higher soil organic carbon (0.42%) was near the tree line at distance 2-6m and was decreased with increase in distance from the tree line and at distance 10-14 m was on par with the control (Without trees). The higher organic carbon content near tree line and upper surface of the soil layer could be attributed due to continuous addition of organic matter by trees on upper layers and was more near the tree line as compared to away from tree line. Similarly, significantly higher available N, P_2O_5 and K_2O (236.50, 19.13 and 222.24 kg ha^{-1}, respectively) were recorded near the tree line at distance 2-6 m and were decreased with increase in the distance from the tree line and at distance D_3 (10-14 m) were on par with control . The higher status of nutrients near the tree line and upper layer of the soil surface could be attributed due to continuous addition of organic matter by trees. Higher nutrients near the tree line might be due to addition of litter by the trees; more often leaf shedding is restricted to its canopy area and as well as by decaying of roots near the tree line. Jones et al (2017) who reported higher available nutrients under *Faidherbia albida* based agri-silviculture system compared to control (without trees). Similarly, Honnayya et al, (2020) found higher organic carbon and available NPK near tree lines and were decrease with increase in distance from the tree line and reported the influence up to 18 m. Doddabasawa et al, (2017) observed significantly higher organic carbon and available NPK near the tree line in neem based agroforestry systems over control.

Table 3. Influence of bund planted teak (*Tectona grandis* L. f.) trees on grain yield of green gram (*Vigna radiata*), black gram (*Vigna Mungo*) and pigeon pea (*Cajanus cajan*) at different distances from tree line (Grain yield kg ha^{-1})

Treatment	Green gram	Black gram	Pigeon pea
D_1 (2-6m)	456^{a}	662^{ab}	1166^{a}
D_2 (6-10m)	633^{b}	715^{abc}	1406^{b}
D_3 (10-14m)	713^{b}	725^{abc}	1433^{b}
Control (Without trees)	714^{b}	737^{c}	1474^{b}

Table 4. Influence of bund planted teak (*Tectona grandis* L. f.) trees on soil chemical properties at different distances from tree line on western direction

Treatment	P^{H} 1:2.5 (soil: water)	EC (ds/m)	Organic carbon (%)	Avl. N (Kg/ha)	Avl. P_2O_5 (Kg/ha)	Avl. K_2O (Kg/ha)
D_1 (2-6m)	8.14^{a}	0.45^{a}	0.42^{a}	382^{a}	38^{a}	413^{a}
D_2 (6-10m)	8.16^{a}	0.47^{a}	0.31^{b}	308^{b}	26^{b}	378^{b}
D_3 (10-14m)	8.20^{a}	0.48^{a}	0.23^{c}	255^{c}	23^{bc}	295^{bc}
Control (Without trees)	8.22^{a}	0.48^{a}	0.21^{c}	228^{d}	21^{c}	282^{c}

CONCLUSION

The present investigation on influence of bund planted teak trees on field crops indicated significantly lower yield of crops near tree line at 2-6 m and were increased with increase in distance and no effect at distance of 10-14m. The black gram was least affected followed by pigeon pea and green gram. However, significantly higher nutrient status was near the tree line and were decreased with increase in distance from the tree line, over all the negative and positive effects by the bund planted teak trees were extended up to 10 m distance from the tree line.

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Received 22 November, 2023; Accepted 21 May, 2024