RESEARCH ARTICLE

EFFECT OF POPLAR (POPULUS DELTOIDS) SHELTERBELT ON THE YIELD OF AGRICULTURAL CROPS AND SOIL PROPERTIES IN SEMI ARID REGION OF HARYANA

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Received-28.05.2021, Revised-12.06.2021, Accepted-23.06.2021

Abstract: The study was conducted in 2 year old east-west and north-south directions bund plantation at CCS HAU, Hisar during 2016-2017 to evaluate the effect of ***Populus deltoides*** bund planting on the yield of agricultural crops and soil properties in Haryana. Total biomass yield of dhaincha was recorded non significant at different distance from tree line of both east-west and north-south planted rows of eucalypts. Different aspects also had no significant effect on total biomass yield of dhaincha. Same pattern of grain yield of wheat (*T. aestivum*) was recorded in both east-west and north-south planted eucalypts. Poplar planted in east-west direction has attained 8.8 cm girth and 8.7 m height whereas in north-south direction it has attained girth of 3.9 cm and height of 6.0 m. The soil organic carbon and available N, P and K content were recorded maximum in bund planted poplar compared to control in different aspects.

Keywords: Crops, Poplar, Soil, Region Yield

INTRODUCTION

Poplar (*Populus deltoides*) is a fast-growing tree species has been extensively planted in many countries. In addition to growing in plantations for wood production, poplar is also planted in agroforestry systems especially as a fast-growing windbreak and/or an extra income stream for farmers. Eucalyptus species was introduced in India to minimize soil erosion, water logging condition, fuel wood and timber demand. Being as fast growing nature, tree has fulfilled the most of the important agroforestry tree species characteristics. Eucalyptus planting in India started taking shape through extension activities of the state forest departments in the late sixties and early seventies. It gradually gained momentum in all parts of India, especially in Punjab, Haryana, western Uttar Pradesh, Gujarat, Tamil Nadu, North Bengal and Andhra Pradesh. Eucalyptus based agroforestry systems widely adopted in the year of 1990-91. The commercial agroforestry systems have changed the scenario of agroforestry in India. This species is providing the opportunity to fulfill the aim of National Agroforestry Policy 2014 of India to achieve 33 per cent of tree cover (NAP, 2014). To accomplish these objectives, the commercial agroforestry systems are prime important and will provide the numerous direct and indirect output (Chavan *et al.*, 2015, 2016). Commercial trees under agroforestry besides providing the tree products, improves soil productivity through ecological and physico-chemical changes (Chauhan *et al.*, 2012). Under the circumstance it appears worthwhile to exploit the residual nutrients per se in a succeeding crop of different rooting habit (Chaudhary, K. *et al.*, 2017). Eucalyptus based agroforestry system is most commonly accepted practice in India by the farmers for fulfilling the market demand of plywood, paper, pole and furniture industries. The boundary planting of Eucalyptus is preferred by farmers due to their less interference with agricultural operations. Boundary plantation under agroforestry helps in holding the soil against erosion and improving soil fertility by fixing nitrogen or bringing minerals from deep in the soil and depositing them by leaf fall. Such a suitable combination play a vital role in enhancement of better yield productivity, soil nutrient status and microbial population dynamics which plays a major role in nutrient cycling to maintain ecosystem (Raj *et al.*, 2016). Due to shading effect and strong root system of Eucalyptus, which compete for moisture and nutrient with crops resulting grain yield near the tree lines was comparatively low. Boundary plantation of Eucalyptus is very popular in northern India as they are providing extra income to famers with minimum interference with various agricultural operation and crop. Moreover, the small farmers cannot afford to raise block plantation at the cost of agricultural crop yield because the yield reduction ranges from 30-50 % in block plantation whereas 15-20 % in boundary plantation. Eucalyptus characteristics of unbrowasble, coppicing, and conical crown shape have a distinct advantage as boundary planting in recommended inter-row spacing and are aligned east–west or north-south direction. In this environment, Eucalyptus boundaries produce a harvestable tree crop within four to five years after planting (Bargalli *et al.*, 1995). The outcome of yield is depends upon tree spacing, density, type and nature of existing bund plantation and their shading effects. Distance from tree base also played significant role on the yield of grain crops. The yield of crops increased with the increase

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in distance from the boundary tree lines (Kidanu *et al.*, 2005). Further, as a distance increases the grain yield also increases. In India, wheat (Triticum sp.), chickpea (Cicer arietinum), lentil (Lens esculentum) yields were depressed between 2 and 12 m from the tree row (Singh and Kohli, 1992) when trees were grown on field boundaries. Similar reduction in yield of intercrop under Eucalyptus has been reported particularly with age of the tree (Singh *et al.*, 1998). The extent of enrichment in soil properties depends on the tree species, management practices and the quantity and quality of litter and their decay rate Moreover, the leaf litter deposition from Eucalyptus vegetation and resultant soil acidity might also affected intercrop yield. Owing to these negative effects, the positive effects like increased organic matter content from leaf litter decomposition might have resulted in improvement in soil water holding capacity, porosity, texture, essential nutrient and yield improvement of kharif and rabi crop. Eucalyptus plantation results in improvement in soil nutrient (N, P, K, and organic matter) as compared to natural soil (Jan *et al.*, 1996). Eucalyptus plantation can ameliorate salinity and sodicity of soil by improving decreasing soil EC, pH and SAR (Nasim *et al.*, 2007). Therefore, the purpose of this study was to evaluate the effect of different spacings of bund planted Eucalyptus on agricultural crops and soil properties.

MATERIALS AND METHODS

The study was conducted in 2 year old Poplar bund plantation of east-west and north-south directions at CCS Haryana Agricultural University, Hisar during 2016- 2017 situated at 29° 10' N latitude and 75° 40' E longitudes at an elevation of 215 m above mean sea level. The climate of the experimental site is semi-arid and mainly characterized by a hot summer, a short rainy season and a cold winter. Maximum rainfall is received during June to September (monsoon season). The mean annual rainfall is about 650 mm and the mean annual temperature ranges between 16°C and 20°C. Wheat crop (T. aestivum) in rabi and dhaincha (Sesbania sesban) in kharif were raised in association with poplar. The treatments consisted of six distances viz. 0-3, 3-6, 6-9, 9- 12, 12-15 and 15-18 m at 3 m intervals from tree rows upto 18 m. The yield for wheat and dhaincha were recorded at different distances from poplar. Soil samples were collected randomly under different spacing in three replicates from 0-15 cm depth. The soil samples were taken before sowing of crops and also from control field for the study of various soil chemical properties (pH, electrical conductivity and organic carbon) and available nutrients (nitrogen, phosphorus and potassium). The samples were air dried, ground in a wooden pestle with mortar, passed through a 2 mm stainless steel sieve and stored for subsequent analysis. The soil pH and electrical conductivity were determined in soil: distilled water suspension (1:2). The available N in the soil was determined by alkaline permanganate method (Subbiah and Asija, 1956), organic carbon by partial oxidation method (Walkley and Black, 1934), available P by sodium bicarbonate method (Olsen *et al.*, 1954) and available K by neutral normal ammonium acetate method (Jackson 1973). The experiment was conducted in randomized block design and data obtained during the course of this investigation, were analyzed by using standard statistical procedure (Panse and Sukhatme, 1989).

RESULTS AND DISCUSSION

Performance of crops with Poplar

Poplar planted in east-west direction had attained 8.8 cm DBH and 8.7 m height, however, in north-south direction it had attained girth of 3.9 cm and height of 6.0 m. Total biomass yield of dhaincha was non significant affected to all distance from tree line of both east-west and north-south planted rows of poplar (Table 1). Different aspects had no significant effect on total biomass yield of dhaincha. The visual observations made for wheat (Table 2) and dhaincha crop growing with poplar as boundary plantation revealed that the growth of the crop plants were poor near the tree bases whereas growth were improved as moved towards the tree line in each direction from the centre of the field. The establishment of crop was poor near the tree line. This resulted in overall decline in the wheat and dhaincha crop yield near the plantation line. In case of boundary plantation, the biomass of crops was found slightly more in east-west direction than north-south direction. The maximum biomass yield of dhaincha was recorded 15-18 m distance from tree rows under both the north-south and east-west planted row of poplar. The grain yield of wheat recorded maximum in 12-15 m distance from the bund plantation in east-west planted poplar (Table 2). However, in north-south direction the grain yield of wheat was found with a maximum value of 3.24 t/ha in 9-12 m distance from tree line plantation. This erratic trend of yield of wheat was because of age and height of poplar. At early age of bund plantation of poplar the agriculture crops may not affect much because of less shade area of tree during the crop growing period. The findings of the study are in line with the Sharma *et al.*, (2007), Chauhan *et al.*, (2012) and Alebachew *et al.*, (2015) in different tree species.

Table 1. Effect of row direction and distance from the tree row of bund planted poplar on green biomass yield (t/ha) of dhaincha

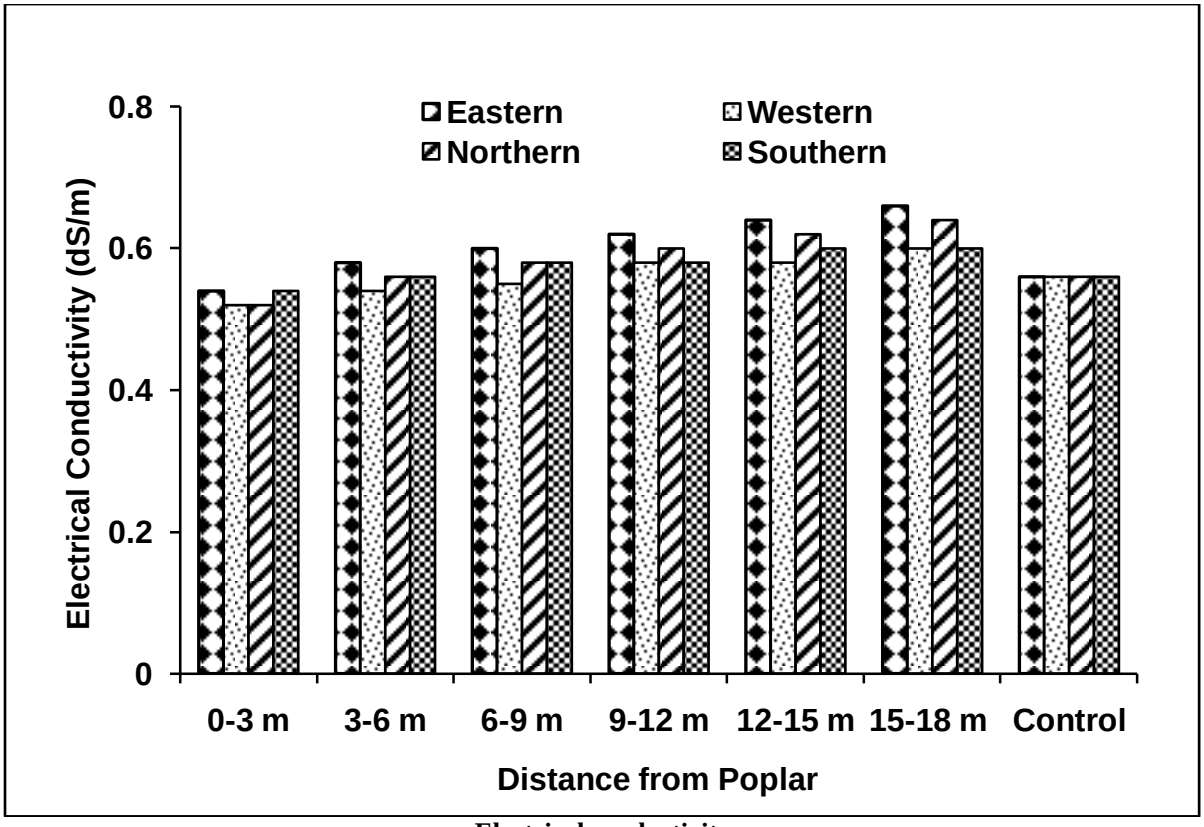
Distance from tree row (m)	**East-West Row**			**North-South Row**		
	Northern aspect	Southern aspect	Mean	Eastern aspect	Western aspect	Mean
0-3	7.8	8.0	7.9	8.0	8.2	8.1
3-6	7.7	7.9	7.8	7.7	7.9	7.8
6-9	7.8	7.7	7.8	7.8	8.0	7.9
9-12	7.5	7.7	7.6	8.2	8.1	8.2
12-15	7.7	8.2	8.0	7.8	8.1	8.0
15-18	8.0	7.6	7.8	7.9	8.2	8.1
Mean	7.8	7.9		7.9	8.1	
CD at 5%	Distance : NS			Distance : NS		
	Aspect: NS			Aspect: NS		
	Distance × aspect: NS			Distance × aspect: NS		

Table 2. Effect of row direction and distance from the tree row of bund planted poplar on grain yield (t/ha) of wheat

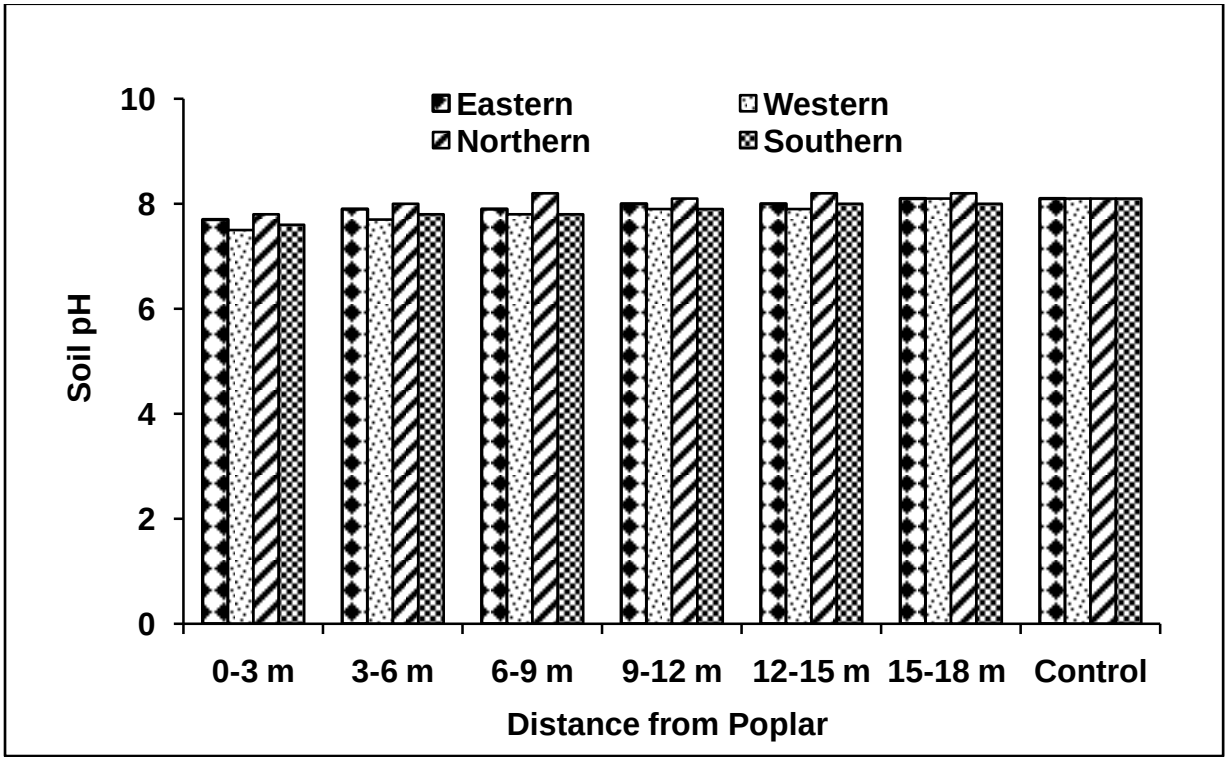
Distance from tree row (m)	**East-West Row**			**North-South Row**		
	Northern aspect	Southern aspect	Mean	Eastern aspect	Western aspect	Mean
0-3	3.15	3.16	3.16	3.18	3.16	3.17
3-6	3.19	3.15	3.17	3.16	3.17	3.17
6-9	3.21	3.22	3.22	3.18	3.19	3.19
9-12	3.24	3.18	3.21	3.24	3.22	3.18
12-15	3.26	3.20	3.23	3.20	3.16	3.21
15-18	3.21	3.19	3.20	3.21	3.20	3.22
Mean	3.21	3.18		3.20	3.18	
CD at 5%	Distance : NS			Distance: NS		
	Aspect: NS			Aspect: NS		
	Distance × aspect: NS			Distance × aspect: NS		

Effect on soil properties

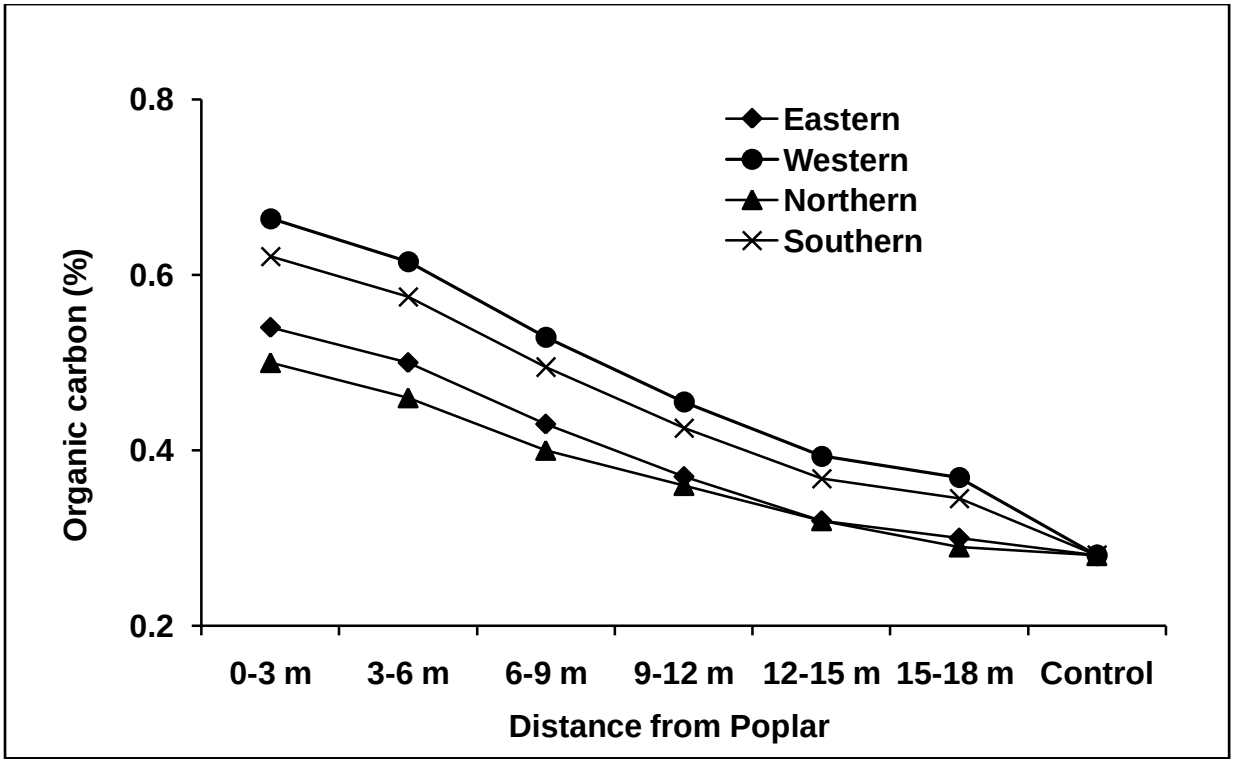
Generally soils under tree species modifies the nutrient status by adding leaf litter, leachates, chemicals from roots. Boundary plantation had the significant changes in the soil properties. Various soil properties viz pH, electrical conductivity, organic carbon, available N, P and K content was portrayed in Fig 1. Initially the observed value of soil pH, EC and OC were 8.2 0.82 and 0.34 respectively. A nominal increase in soil pH and EC was observed with increase in distance from tree line. The similar trend was followed in northern and southern aspect. The soil organic carbon and available N, P and K content were significantly higher in the western aspect in 3 m distance of poplar based agroforestry system whereas, a decreasing trend was observed in average contents of soil organic carbon, N, P and K and organic carbon in agroforestry system with the eastern aspect of poplar plantation (Fig. 1). Among all the different aspects in various distances organic carbon decreased as the distance from tree was increased. It was 0.54, 0.50, 0.46, 0.38, 0.34 and 0.32% and 0.52, 0.48, 0.44, 0.38, 0.32, 0.30% for western and eastern aspect respectively. The status of organic carbon, N, P, and K were significantly higher in western aspect of 3m distance where as it was lowest under control. Amongst northern and southern aspect, organic carbon content was more in southern aspect at all the distances from tree line of poplar. As like western and eastern aspect a decreasing trend with the distance from was also observed in northern and western aspect also. Organic matter and available nutrient status of western aspect was highest and it was closely followed by southern aspect. Among all the different aspects the status of organic carbon (0.54%), N (210 kg ha -1), P (15 kg ha-1), and K (280 kg ha-1) were also significantly higher in western aspect in 3 m distance where as it was lowest under control (Fig. 1).



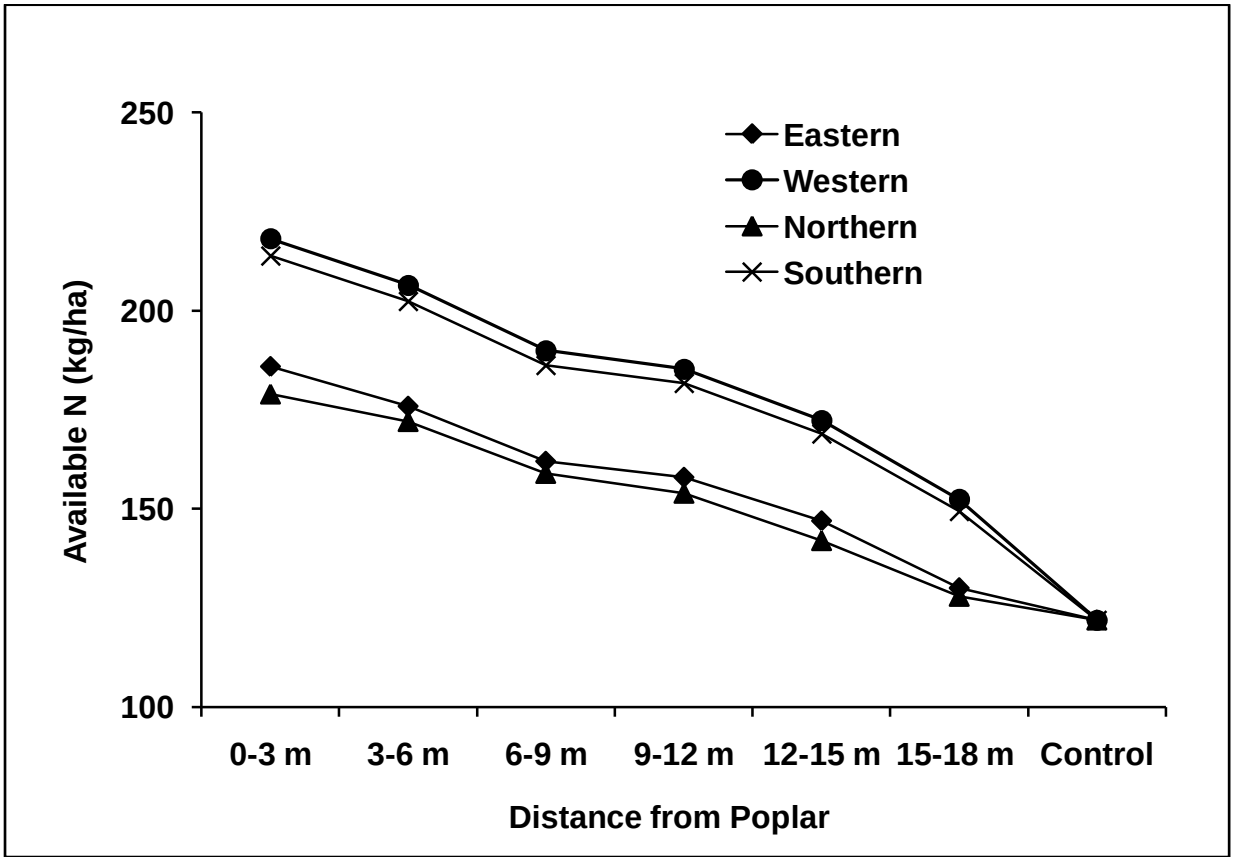
Electrical conductivity



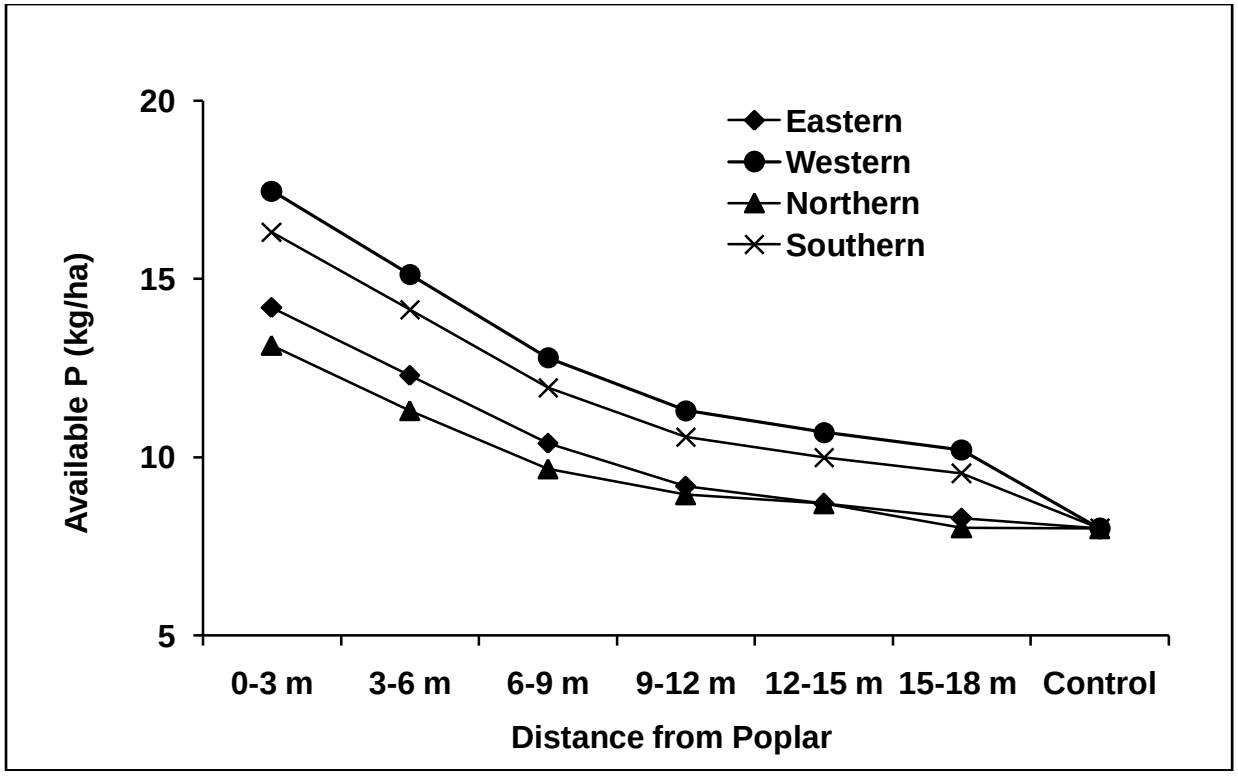
Soil pH



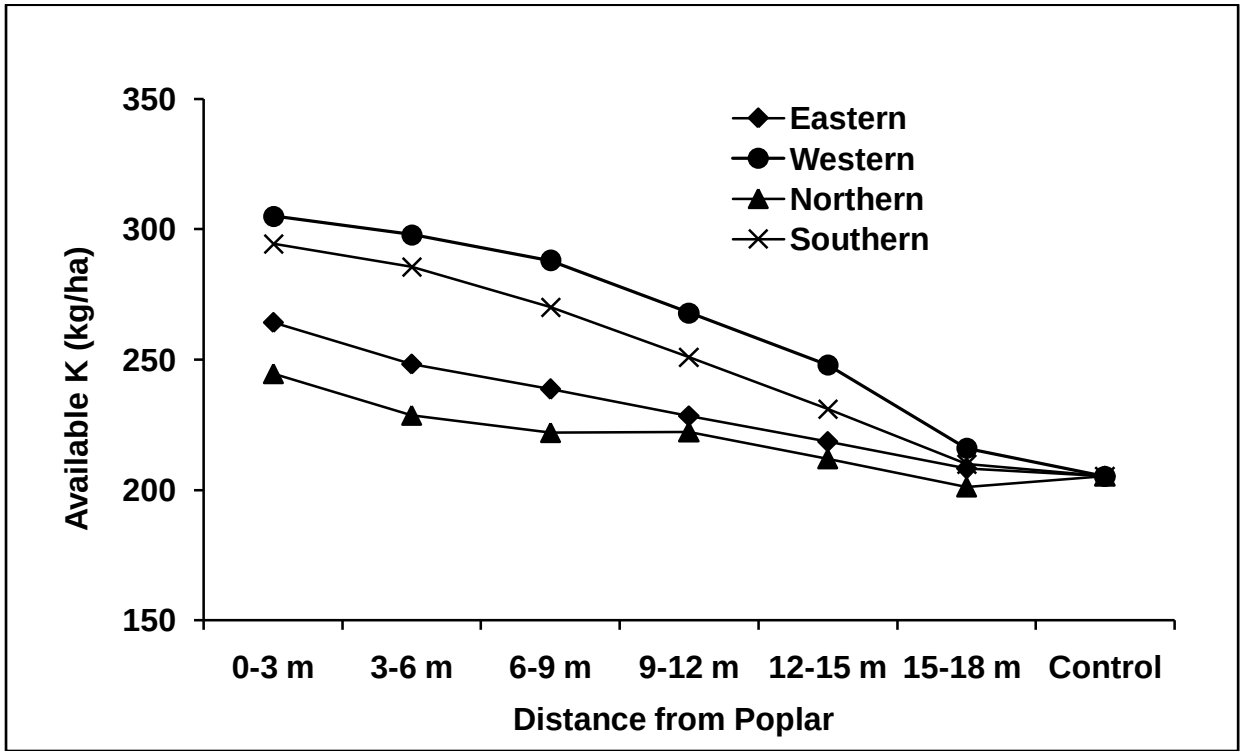
Organic carbon



Available N



Available P



Available K

Fig. 1: Effect of eucalyptus bund plantation on various soil properties

The reduction of soil pH and EC closer to tree can be attributed to accumulation and subsequent decomposition of organic matter which releases organic acids (Gupta and Sharma, 2009). The higher nutrient status near the tree might be due to the addition of large quantity of leaf litter. The higher decomposition of leaf litter favours the higher nutrient status of the soil. Similar findings were also observed by Singh and Sharma (2007). Increase in soil carbon through plantations may also act as an important carbon sink. The higher available nutrient content in agroforestry system over the agriculture

system may be attributed to litterfall addition from trees as well as addition of root residues of crops and trees. These findings were supported by (Gupta and Sharma, 2009). On account of recycling of organic matter, higher organic carbon and available N, P and K contents were observed in the soil under intercropped eucalyptus plantations than at a site without trees and the contents varied depending upon the intercrops. The impact of agroforestry systems on soil fertility in terms of higher organic matter content, total nitrogen, available phosphorus and potash in the top soil has been reported by Uthappa *et al.*, (2015). Increase in tree litter and nutrients increases with increasing plantation age (Bargali, 1995).

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