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Review Article

Tree-Crop Interactions in Agroforestry Systems

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Abstract

Allelopathy refers to the inhibition of growth of one plant by chemical compounds released into the soil from neighboring plants. The understory crop in an agroforestry system exoerience profound effect of tree residues in the soil besides the modified microenvironment. However under changing climatic scenarios agroforestry is being proved boon. There are several characteristics that could be identified as desirable attributes for trees in agroforestry system.The positive interactions at the tree-crop interface are microclimate modification and nutrient balance. Microclimate amelioration involvs soil moisture and soil temperature modification. This paper discusses the pros and cons of agroforestry systems.

Keywords

Crop Growth; Modified Microclimate; Agroforestry; Climate Change.

Introduction

Agroforestry is a practice provides a varied land use option, rather than traditional arable and forestry systems. It is a better option to exploit the available resources can be more effectively under changing climatic scenarios as it is a popular tool to modify the microclimatic conditions under field conditions, mainly radiation, relative humidity, carbondioxide concentration, wind velocity and soil environment to the understory crop.. modern practices of agroforestry are adapted to the constraints imposed by global warming. it allows for the diversification of farm management which makes better use of natural resources. Tree crop integration results into many types of interactions by changing microclimate, which affect the productivity of component crop. this paper discusses the effect on understory crop of trees.

Effect of trees on growth of understory crop

The effects of aqueous extracts of mature leaves of *Azadirachta indica, Terminalia arjuna, Dalbergia sissoo, Albizzia lebbek [Albizia lebbeck], Sesbania grandiflora, Acacia auriculiformis* and *Leucaena leucocephala* were studied on the germination responses of wheat (*Triticum aestivum*), paddy (*Oryza sativa*) and gram (*Cicer arietinum*) in petri dishes. Extracts significantly reduced the germination of test crops. Among all the tree species, maximum inhibition of germination was caused by*Sesbania grandiflora*, followed by *Acacia auriculiformis*. The magnitude of reduction was least in wheat and most in gram. The decrease in germination was directly proportional to the increase in concentration of leaf extract. (Rao et. Al., 1994)

Allelopathic potential of Pinus needles on seed germination and early seedling growth of Wheat and Mustard were studied. the toxic effects allelochemicals from Pinus needles on Wheat and Mustard seeds. The main aim of this study is to draw attention to the allelopathic potential of phenolic compounds present in pine needles in as the main cause of reduction in crop production.

Pinus needles extract showed allelopathic activity again st wheat and mustard. Predominance of Pinus roxburghii in the mountain region in India is a known phenomenon. Every season the fallen needles form a bed on the forest floor. In rainy season allelochemicals from pinus needles get dissolved with water and mixed in to the soil. These allelochemicals are added to mountain soils every year and these could be a possible cause for reduced crop production in

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mountain regions of India and World. Predominance of Pinus roxburghii could be a possible cause for reduced crop production in mountain regions of India and World. (Baroniya and Baroniya, 2014)

Basu *et al.* (1987) reported that wheat showed marked reduction in growth near the *Eucalyptus. tereticornis.* Since crop near the *Eucalyptus tereticornis* was not competing for water, it was suggested that crop response was caused due to allelopathic substances leaching from *Eucalyptus tereticornis* litter in the plot nearest the tree.

Sharma *et al.* (1987) found that germination and growth of wheat, field peas and lentil was not much affected by the leaf leachates of *Acacia nilotica, Eucalyptus* 'hybird', *Dalbergia sissoo* and *Morus alba* except rye. Generally root and shoot length was reduced by leachates as compared to control in order of *Morus alba* > *Dalbergia sissoo* > *Eucalyptus* 'hybrid' > *Acacia nilotica.*

Sunita Prasad (1987) studied the influence of leaf leachates and litter of *Eucalyptus tereticornis* and *Populus deltoides* on germination of wheat and gram seeds. The selective inhibitory influence of leaf leachates was found. The degree of inhibition effect was more for summer collected leaf than winter.

Joshi (1988) studied the allelopathic effect of fresh and partially decomposed leaf litter extract of ten forest trees namely, *Eucalyptus 'hybird', Sesbania aculeata, Azadirachta indica, Leucaena leucocephala, Populus deltoides, Bombax ceiba, Syzygium cumini, Dalbergia sissoo, Casuarina equisetifolia* and *Albizia lebbeck* on germination and seedling growth of wheat, maize, peas and rapeseeds. The extract of fresh leaf residue of all the tree species not only delayed but also reduced germination and seedling growth in all the crops and it was directly related to the concentration of phenolic compounds. The degree of reduction varied from 2-30 per cent for wheat, 0-25 per cent in maize and peas and 100 per cent in rapeseeds. Extracts from partially decomposed litter were less inhibitory to seed germination of rape seeds. Peas was most affected by both fresh and partially decomposed litter extracts than the germination of wheat and maize.

Alam (1990) studied about the effect of *Cassia angustifolia, Sphaeranthus indicus* and *Azadirachta indica* leaf extract on wheat seedling growth and seed germination and found that germination was unaffected by extract but shoot growth was significantly increased by increasing extract concentration.

Bansal (1992) studied the allelopathic effect of *Eucalyptus marcrorhyncha* and *Eucalyptus youmanni* on seedling growth of wheat and radish and found that root and shoot growth of wheat and radish were not affected by 1 and 2 per cent extracts of *Eucalyptus marcrorhyncha* although root length of 'VL-421' wheat was inhibited markedly by 5 per cent extract and shoot length slightly.

Sharma (1992) studied the influence of *Acacia nilotica* on growth performance of associated wheat crop and reported that tree line did not affect shoot numbers, ear length and number of grains in spike in vicinity of trees up to 4 m distance from the tree line.

Bisla *et al.* (1992) studied the influence of leaf extracts of *Eucalyptus tereticornis* and *Populus deltoides* on seed germination and seedling growth of wheat (*Triticum aestivum*), barley, lentil, chickpea and mustard. The activity varied with the extract concentration and in some cases, initial stimulatory effects were obtained. The inhibitory effect of *Eucalyptus tereticornis* was less than that of *Populus deltoides.*

Thakur and Bhardwaj (1992) reported no significant affect on wheat germination of leaf extracts of leachates of *Eucalyptus globulus, Populus ciliata, Juglans regia* and *Robinia pseudoacacia.*

Pant (1993) found increase in wheat germination by 15, 11 and 14 per cent as compared to sole crop under jamun, guthel and eucalyptus canopy, respectively, but a reduction of 12 per cent under poplar.

Sahu (1995) reported higher germination of wheat seeds under all the tree species viz., *Eucalyptus 'hybird', Trewia nudiflora* and *Syzygium cumini* except in *Populus deltoides*. There was 5 per cent reduction in germination of wheat seeds under poplar as compared to sole crop.

Effect of Trees on the Yield of Various Crops

Decreases light intensity due to shading adversely affects plant growth and development. study showed that the mean crop growth rate, mean relative growth rate, net assimilation rate, leaf area ratio, leaf area index and specific leaf weight were significantly influenced by increasing shade. Grain yield of all the wheat varieties decreased with increase in shading during the year.

Dhillon *et al.* (1979) studied the effect of eucalyptus on the adjoining crop and found the reduction in grain / paddy yields of wheat and rice grown on S. aspect of E - W line of trees was greater than when grown on the N aspect.

Khattak and Sheikh (1980) found no significant difference in the wheat yield during first year under

the canopy of *Dalbergia sissoo, Eucalyptus citriodora, Populus deltoides* and *Salmalia malabaricum* but the yield was significantly increased under *Dalbergia sissoo* in the next year. Keerio (1982) studied the effect of wind break on cotton and wheat yield and found that cotton yields was increased by 5 per cent and wheat yields, by 7.5 per cent due to effect of wind break as compared to open fields.

Sheikh and Khalique (1982) reported no effect on the yield of wheat cv. Pavan near the 3 rows of shelterbelts of *Eucalyptus camaldulensis.* However, cotton cv. N - T gave maximum yield only when 60 - 75 m from the trees; low yield resulted from sowing within 15 - 20 m.

Sheikh *et al.* (1983) determined the effect of four year old hybrid poplars (av. height 15 m and diameter 19 cm, planted at 5.5 x 5.5 m^2 spacing) on the yield of wheat at 0.75, 1.75 and 2.75 m distances from the trunk of tree and reported no significant differences in wheat yields at different distances.

Bereberdin *et al.* (1983) in an agrosilvicultural system recorded higher winter survival of plants and wheat grain yield when cropped in the spaces between 5 - 12.5 m apart from wind breaks as compared with wheat grown in unprotected fields. Grain yield reduced significantly with an increase in the distance from wind break.

Grahlmann (1986) studied the effect of hedgerows on the yield of crop plants and found that dens hedges of deciduous tree species at the south field edge decreased yields of 56 winter barley fields by about 17 per cent in the strip whose width was 1.75 times the hedge height and increase in grain moisture even in dry years.

Gill and Patil (1988) recommended wheat variety Raj-1555 for growing under subabul with 45.85 q ha^{-1} yield in the open and 50.07 q ha^{-1} under canopy.

Joshi (1988) found better growth and yield of wheat and paddy under soil incorporated residue of neem, sesbania and subabul and poor growth and yield under poplar, semal, jamun and eucalyptus species.

Kong *et al.* (1989) reported that the yield of wheat intercropped with paulownia was increased by 6.15-9.25 per cent . Inter cropping with paulownia reduced soil moisture loss and improved site conditions.

Kohili *et al.* (1990) studied the influence of shelterbelts of *Eucalyptus tereticornis* (nearly 8 year old and of average D.B.H. 25.5 cm) on 6 winter crops (chickpea, lentil, wheat, cauliflower, toria and barseem) in terms of plant density, root and shoot growth, biomass and economic yield, found to be negative upto 11m to the south of trees. Beyond 11 m no influence of trees were noticed.

Roy and Gill (1991) conducted an experiment with 12 multipurpose tree species (*Casuarina, Emblica, Eucalyptus, Leucaena, Dalbergia, Madhuca, Acacia* (2 species), *Melia, Albizia, Syzygium, Hardwickia)* under an agrosilvicultural system and found that grain production of wheat was reduced under tree canopies.

Jafri *et al.* (1991) studied the effect of wind breaks of shisham and semal on wheat yield under irrigated conditions and reported the loss of grain yield especially near the tree row.

Puri and Bangarwa (1992) conducted a study on 4 tree species to determine the effects on wheat yield *Azadirachta indica* (6/ha), *Acacia nilotica* (12/ha), *Prosopis cineraria* (25/ha) and *Dalbergia sissoo* (20/ha) and found that wheat yields under *A. indica* and *P. cinerania* at 1,3,5,7 in distances and in 4 directions (east, west, north and south) from tree base were not significantly different while under *A. nilotica* and *D. sissoo* yield reduction were 40-60 per cent and 4-30 per cent, respectively.

Sahay (1992) reported successful inter cropping of groundnut, ladyfinger (okra) and wheat with eucalyptus and reported good yield when crops planted in ploughed strips between eucalyptus rows.

Sharma and Singh (1992) studied the effect on the wheat yield bordered by a single row plantation of *Populus* 'G-3' (6 year old) and found that the grain yield was increased near the tree line (24.53 q/ha at < 4m distance vs. 18.07-20.91 q/ha in the other distance classes). A small reduction in yield was found at 4-8 m distance.

Pant (1993) conducted a study on intercropping of wheat with *Eucalyptus 'hybird', Populus deltoides* (clone G-3), *Syzygium cumini* and *Trewia nudiflora* and found that the different tree species showed a variable effect on growth and yield of wheat. Average grain yield varied from 22.50 q/ha under eucalyptus to 27.09 q/ha as sole crop. Average grain yield of wheat was 7.1 to 16.5 per cent and straw yield 5-25 per cent lower under tree canopies in comparision to control.

Kundu (1994) studied the effect of tree species viz. *Dalbergia sissoo* (shisham), *Bombax malabericum* (semal), *Tectona grandis* (teak), *Albizia lebbeck* (siris) and *Trewia nudiflora* (guthel) on the growth and yield of wheat. All the tree speices showed beneficial effect on germination and all the growth parameters of wheat crop but grain yield was 16-23 percent lower under tree canopies as compared to control (sole crop).

Sahu (1995) conducted an experiment on wheat intercropped with poplar, eucalyptus, guthel and jamun and reported that grain yield of wheat was reduced by 10-15 per cent under tree species as

compared to sole crop.

Chauhan *et al.* (1995) conducted the study on effect on wheat yield of *Morus alba, Populus deltoides, Albizia procera* and *Lucaena leucocephala* in rainfed conditions and found increased wheat yield at 10 and 8 m distance from *Albizia procera* and lower yield at 6,4 and 2 m distance from tree. Mulberi and poplar showed reduced yield upto 4m. Over all yields were higher under subabul, where these were not much reduced from the no tree yields.

Chirko *et al.* (1996) studied the effect on microclimate of paulownia intercropping with wheat crop and found that tree shade did not have some effect on wheat yield, factor such as tree morphology (a long clean bole), N.S. tree row orientation and wide inter row spacing resulted in a compatible intercrop system between paulownia trees and wheat.

Nadagouda *et al.* (1997) conducted a study on eucalyptus along with field crops under irrigated conditions. Pearlmillet, maize, groundnut, pegionpea and cotton were raised between eucalyptus (5 year old). The extent of adverse effect was maximum on maize and minimum on cotton. The yield were significantly higher on western side than on eastern side.

Conclusion

The total production from an agroforestry plot is more than the separate production obtained by an arable-forest separate cropping pattern on the same area of land as weeds, present in young forestry plantations are replaced by harvested crops or pasture; maintenance is less costly and environmental resources are better used. However thereare some adverse effect on the crop dur to various factors. It also counteract the greenhouse effect by constitution of an effective system for carbon sequestration. Further project oriented research is needed in this regard.

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