Eco. Env. & Cons. 22 (June Suppl.) : 2016; pp. (S123-S127)
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ISSN 0971–765X

Effect of different tillage practices on production of mustard in 10-year old *Dalbergia sissoo* based agroforestry system

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(Received 15 December, 2015; accepted 10 February, 2016)

ABSTRACT

The field experiment was conducted to test the effect of different tillage practices on production of mustard in 10-year-old *Dalbergia sissoo* based Silvi-Agriculture system at National Research Center for Agroforestry, Jhansi, India. during rabi season. Growth and yield attributes were recorded on both the components viz., trees and crops and were analyzed in Randomized Block Design by applying the technique of analysis of variance ($P<0.05$). In general, growth parameters of agri-component at different distances from the tree base (0.5 m, 1.0 m, 2.0 m, 3.0 m and 4.0 m) viz., average germination, number of branches plant^{-1}, plant height, length of siliquae (cm), number of siliquae plant^{-1}, number of grain siliquae^{-1}, test weight (1000 seeds), grain yield (gm) in 0.5 m^2 quadrate grain yield (Kg ha^{-1}) were 19.47 %, 7.92 %, 34.80 %, 4.74 %, 6.50%, 6.27%, 7.89 %, 6.46%, 160% significantly higher in plots treated with deep ploughing than in plots treated with normal tillage. It was found that agri component growth and yield performance was better in pure crop (182.24 %) when compared to tree crop interaction. While growth and productivity attributes of tree components were found slightly better in normal ploughing (ploughed with cultivar) than in deep ploughing (ploughed with disc plough), though the differences were statistically not significant.

Key words : *Tillage practices, Dalbergia sissoo, Agroforestry*

Introduction

Agroforestry systems include both traditional and modern land-use systems where trees are managed together with crops and/or animal production systems in agricultural settings. When designed and implemented correctly, agroforestry combines the best practices of tree growing and agricultural systems resulting in more sustainable use of land (Gérard, 2013). However, when trees and crops grow in close proximity to each other they do not always interact in complementary ways, they may often interact in competitive ways too (Wise and Oscar, 2008) due to strong competition for available resources (Newaj *et al.,* 2001). Agroforestry system can be more productive than either than pure agriculture or pure tree system provided that viable management practices are employed to reduce competition between tree-crop components for growth resources.

In the present paper, attempts were made to work out effect of different tillage practices on production of mustard in 10-year old *Dalbergia sissoo Roxb.* based agroforestry system. *Dalbergia sissoo Roxb.* (Family: Leguminosae) is a known premier timber species from the rosewood genus, it is native

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to Sub-Himalayan zone including India, Pakistan and Afghanistan (Lodhiyal and Lodhiyal, 2003). It is also recognized as an important species for fuel wood, shade tree and fodder tree in agroforestry systems (French and Mathiesen, 1995). It has been widely used for afforestation in most parts of the India except in the very hot, cold and wet tracts. Rapeseed-mustard is the third important oil seed crop in the world after *Glycine max* and *Elaeisguineensis Jacq.* oil. The global production of rapeseed-mustard and its oil is around 38–42 and 12–14 mt, respectively. Among the seven edible oilseed cultivated in India, rapeseed-mustard (*Brassica spp.*) contributes 28.6% in the total production of oilseeds. In India, it is the second most important edible oilseed after groundnut sharing 27.8% in the India's oil seed economy. India contributes 28.3% and 19.8% in world acreage and production (Kapila, *et al*., 2012). In much of the on-going studies there is very little information available on role of management practices in minimizing negative impacts of *Dalbergia sissoo*-mustard tree –crop system for increasing productivity of the system, hence this study is undertaken.

Materials and Methods

The current investigation was carried at research farm of National Research center for Agroforestry, Jhansi (India). (The site of experimental field is situated at 250 27′ North latitude and 780 35′ East longitudes, 271 meters above mean sea level in the semiarid tract of central plateau of India) during Rabi season. The soil of the experimental field was intermixed black and red soil, which represent parawa group of soil under the order of Alfisol. This region receives about 80 % annual rainfall during southwest monsoon with annual rainfall ranging from 700-1150 mm. Two different kinds of tillage practices were tested viz., normal ploughing (ploughing with cultivator) and deep ploughing (ploughing with disc plough) under 10- year old *Dalbergia sissoo* plantation blocks (each block containing 48 standing trees with 8m x 4m spacing). A common pruning up to 70 % tree height was done every year before sowing of mustard (Varuna variety), which is intercropped in tree plantation. The whole field was divided in two blocks; one block was ploughed with disc plough and other block was ploughed with cultivator before sowing of the intercrop. Growth, yield and yield attributing characters of crop such as average germination per cent, plant height at harvest, number of branches plant^{-1}, number of siliquae plant^{-1}, length of siliquae, number of grains siliquae^{-1}, test weight of one thousand seeds, grain yield hectare^{-1} were recorded at different distances from tree base viz., 0.5m, 1m, 2m, 3m and 4m.

Growth parameters of tree component such as height, dbh, and crown diameter recorded. Basal area was determined by using rope method (Satyamurthi, 1997). Volume is dittermined by Hoppus rule, i.e. $V= (g/4)^2x\ l$ (Panwar and Bhardwaj, 2005). Above ground biomass was worked out by multiplying volume with wood density of 0.75 tonnes/m^3 of *Dalbergia sissoo* (Reyes *et al.*, 1992). Below ground biomass was calculated by using simple default value of 25% (for hardwood species) of the above ground biomass as recommended by IPCC, 2006. The statistical analysis of various data collected during the time of experimentation was done on the pattern of Random Block Design by applying the technique of analysis of variance as advocated by Fisher (1968).

Results and Discussion

Over the course of the study, analysis of variance showed significant differences in number of germinated plants, number of branches plant^{-1}, plant height (cm), length of siliquae (cm), number of siliquae plant^{-1}, number of grain siliquae^{-1}, test weight (1000 seeds), grain yield (gm) in 0.5m^2 quadrate and grain yield (kg ha^{-1}) as influenced by different tillage treatments at different distances from tree row, which were 19.47 %, 7.92 %, 34.80 %, 4.74 %, 6.50%, 6.27%, 7.89 %, 6.46%, 160% significantly higher in plots treated with deep ploughing than in plots treated with normal tillage. The entire results were summarized in Table 1, 2 and 3. For all the above-mentioned parameters significantly better results were observed in plots treated with deep tillage at 5 m distance of planting from the tree row and were vice-versa at 0.5 m distance of planting from the tree row in plots treated with normal tillage practice.

The growth and yield attributing characters were observed less at 0.5m distance from the tree base and sharply increases along with the increase in the distance from tree base. This was due to the fact that near the tree base competition for light, nutrients and moisture is more and it goes on decreasing on moving distant from the tree base (Sharma *et al.*,

Table 1. Effect of different tillage practices on germination, plant height and No. of branches plant^{-1} at harvesting stage of mustard crop under 10 year old *D. sissoo* plantation.

Treatments	Germinated plants at 30 days after sowing in 0.5 m^2 quadrate					Plant height (cm) at maturity					No. of branches plant^{-1} at harvesting stage				
	Distance from the tree base					Distance from the tree base					Distance from the tree base				
	0.5 m	1 m	2 m	3 m	4m	0.5 m	1 m	2 m	3 m	4 m	0.5 m	1 m	2 m	3 m	4 m
Normal ploughing (cultivator)	2.70	3.00	3.90	4.40	5.00	111.60	120.40	132.60	135.60	145.40	5.50	6.30	9.50	12.40	14.30
Deep ploughing (Disk plough)	3.40	3.90	4.60	5.30	5.50	119.80	124.80	137.20	142.20	150.00	6.50	6.80	10.30	13.20	15.00
LSD (0.05)	0.34	0.38	0.34	0.28	0.44	1.84	0.68	1.11	2.26	1.24	0.71	0.44	0.56	0.56	0.34
Pure crop	6.70	148.75	15.67												

Table 2. Effect of different tillage practices on No. of siliquae plant^{-1}, Length of siliquae plant^{-1} (cm) and No. of seeds siliquae^{-1} of mustard crop under 10 year old *D. sissoo* plantation.

Treatments	No. ofsiliquae plant^{-1}					Length of siliquae plant^{-1} (cm)					No. of seeds siliquae^{-1}				
	Distance from the tree base					Distance from the tree base					Distance from the tree base				
	0.5 m	1 m	2 m	3 m	4m	0.5 m	1 m	2 m	3 m	4 m	0.5 m	1 m	2 m	3 m	4 m
Normal ploughing (cultivator)	64.86	98.46	116.40	132.40	160.20	4.79	5.21	5.38	5.48	5.70	7.78	10.60	13.40	14.30	15.26
Deep ploughing (Disk plough)	70.33	103.80	123.60	141.00	170.84	5.02	5.44	5.60	5.80	5.96	8.12	11.90	14.18	15.20	15.82
LSD (0.05)	2.70	2.18	1.86	4.45	2.02	0.09	0.12	0.06	0.24	0.13	0.17	0.56	0.65	0.68	0.38
Pure crop	216.65	6.42	16.50												

Table 3. Effect of different tillage practices on Test weight of 1000 seeds (gm), Grain yield in 0.5 m^2 quadrate (gm) and Grain yield Kg ha^{-1} of mustard crop under 10 year old *D. sissoo* plantation.

Treatments	Test weight of 1000 seeds (gm)					Grain yield in 0.5 m^2 quadrate (gm)					Grain yield Kg ha^{-1}
	Distance from the tree base					Distance from the tree base					
	0.5 m	1 m	2 m	3 m	4m	0.5 m	1 m	2 m	3 m	4 m	
Normal ploughing (cultivator)	3.70	3.88	4.34	4.42	4.96	5.03	8.87	14.29	15.60	17.34	0.245
Deep ploughing (Disk plough)	3.90	4.28	4.66	4.94	5.20	5.45	9.54	15.44	16.18	18.50	0.260
LSD (0.05)	0.15	0.28	0.06	0.27	0.14	0.35	0.51	0.54	0.22	0.35	0.003
Pure crop	5.60	35.63	0.713								

Table 4. Growth performance of *D. sissoo* at the age of 10 year under different management practices

Treatment	Height (m)	DBH (cm)	Crown diameter (m)	Basal area (m^2)	Volume (m^3)	Total biomass (m^3)
Normal ploughing (cultivator)	11.61	19.40	6.46	8.90	43.00	51.32
Deep ploughing (Disk plough)	10.98	19.04	6.04	9.24	47.20	56.33
LSD (0.05)	NS	NS	NS			

2000). Germination, number of branches plant^{-1}, plant height (cm), length of siliquae (cm), number of siliquae plant^{-1}, number of grain siliquae^{-1}, test weight (1000 seeds), grain yield (g) in 0.5 m^2 quadrate and grain yield (Kg ha^{-1}) were 19.47%, 7.92%, 34.80%, 4.74%, 6.50%, 6.27%, 7.89%, 6.46%, 160% significantly higher in plots treated with deep ploughing than in plots treated with normal tillage. These results are similar to that of Kayode and Ademiluyi (2004) who observed the shortest maize plant in the No Tillage plots in comparison with that in the tilled plots on a sandy clay loam alfisol in Southwestern Nigeria. Videnoviæ *et al.,* (2011) observed higher maize yield in plots treated with deep tillage than in normal tillage plots on the chernozem soil type in Zemun Polje, Serbia. Ishaq *et al*., (2001) reported higher wheat grain yield under conventional tillage as compared with that under minimum tillage on sandy clay loam soil (LuvicYermosol) in Faisalabad in the semi-arid region of Pakistan. Korwar and Radder (1994) also made similar observations in which deep ploughing (30 cm) along the Lucaena hedgerow reduced the competition between Lucaena hedgerow and crop and increased grain yield and stover yield of alley cropped sorghum. This may be due to the lack of soil loosening for providing conditions favourable to crop growth and yield in plots treated with normal tillage. Better results were obtained from the plots treated with deep ploughing, this may be due to moisture conservation, reduced penetration resistance in the soil profile, removal of lateral roots of the trees standing in agricultural fields (Tewari *et al.,* 2006) and improved soil aeration (Polthanee and Wannapat, 2000). Thus minimizes the competition with the associated crops.

The results of tillage practices on growth of 10-year old *Dalbergia sissoo* showed that volume, above ground biomass and below ground biomass was higher under normal ploughing than deep ploughing, which are summarized in Table 4. Overall the performance of the trees under normal ploughing was better than deep ploughing, though the differences were non-significant. This may be due to fact that fine roots are more liable to get damaged under deep tillage as compared to normal ploughing in upper surface of soil, in absence of feeder roots the tree could not get the benefits of available moisture, soil nutrients and fertilizers applied to the crop during cropping period. (Schroth, 1995).

Conclusion

Agroforestry system can be more productive either than pure agriculture or pure tree system provided that trees and crops are at lest complimentary in use of growth resources (above ground and below ground). Hence, management practices may be a viable option to reduce competition between tree-crop components for growth resources. From this study, it is evident that different tillage practices viz., deep tillage and normal tillage had differential effect on tree and crop in silvi-agriculture system. Deep tillage had a positive effect on mustard while it was vise-versa with respect to tree component of *Dalbergia sissoo.* Total intangible economic values of this agroforestry systems viz. soil-moisture conservation, biological nitrogen fixation etc. should be worked out. Similar kind of investigation with different tree crop densities and age gradations should be worked out in future.

References

Fisher, R.A. 1968. Statistical Methods for Research Workers. 10th Edn. Oliver and Boyd. Edinburgh and London.

French, J.H. and Blicher-Mathiesen, U. 1995. Introduction to the field sites. In: *International Workshop on Agroforestry Investment, Production and Marketing.* Dehra Dun (India), 17-26 Sept. 1995. APAN Report no. 20, FAO/APAN.

Gérard, B. 2013. Advancing Agroforestry on the Policy Agenda- A guide for decision-makers Agroforestry Working Paper no. 1. Food and Agriculture Organization of the United Nations, Rome, 2013.

IPCC Guidelines for National Greenhouse Gas Inventories. 2006. Edited by S. Eggelston, L. Buendia, K. Miwa, T. Ngara and K. Tanabe Published by the Institute for Global Environmental Strategies (IGES) for the IPCC ISBN 4-88788-032-4.

Ishaq, M., Ibrahim, M. and Lal, R. 2001.Tillage effect on nutrient uptake by wheat and cotton as influenced by fertilizer rate. *Soil and Tillage Research.* 62 (1–2): 41–53.

Kapila, S., Rathore, S S., Premi, O.P., Kandpal, B.K. and Chauhan, J.S. 2012. Advances in Agronomic Management of Indian Mustard (*Brassica juncea* (L.) Czernj. Cosson): An Overview, International Journal of Agronomy. Volume 2012. Article ID 408284 14 pages *http://dx.doi.org/10.1155/2012/408284*

Kayode, J. and Ademiluyi, B. 2004. Effect of Tillage Methods on Weed Control and Maize Performance in Southwestern Nigeria Location. *Journal of Sustainable Agriculture.* 23 (3) : 39–45.

Korwar, G.R. and Radder, G.D. 1994. Influence of root pruning and cutting interval of *Leucaena* Hedgerows on performance of Alley cropped rabi sorghum. *Agroforestry Systems.* 25 : 95-109.

Lodhiyal, N. and Lodhiyal, S L. 2003. Biomass and net primary productivity of Bhabar Shisham forests in central Himalaya India. *Forest Ecology and Management.* 176 : 217-235.

Newaj, R.,Ajit, N K. and Handa, A K. 2001. Effect of management practices on rooting pattern of *Dalbergiya sissoo* under agri-silvicultureal system. *Indian Journal of Agricultureal Science.* 71 (1) : 19-20.

Panwar, P. and Bhardwa, J.S. D. 2005. *Handbook of Practical Forestry.* Agrobios (India): 191.

Polthanee, A. and Wannapat, S. 2000. Tillage and mulching affect on growth and yield of cowpea grown following rice in the post-monsoon season of northeastern Thailand. *Kasetsart J.* (*Nat. Sci.*). 34 : 197-204.

Reyes, G., Brown, S., Chapman, J. and Lugo, A E. 1992. Wood densities of Tropical tree species General technical report So-88. Published by United States Department of Agriculture, Forest Service Southern Forest Experiment Station. NewOrieans, Louisiana.

Satyamurthi, K R. 1997. Sampling with a rope- a novel and useful method. *Indian Forester.* 105 (1) : 50-56.

Schroth, G. 1995. Tree root characters as criteria for species selection and selection and system Design in agroforestry. *Agroforestry Systems.* 30 : 125-143.

Sharma, N K., Singh, H P. and Dadhwal, K S. 2000. Effect of Poplar (*Populus deltoids*) on Wheat growth at an early stage. *Indian Journal of Soil Conservation* 28I(3): 221-225.

Tiwari, K.R., Sitaula, B.K., Børresen, T. and Bajracharya, R.M. 2006. An assessment of soil quality in Pokhare Khola watershed of the Middle Mountains in Nepal. *J. Food Agric Environ.* 4(3 & 4) : 276–283.

Videnoviæ, •., Simiæ, M., Srdiæ, J. and Dumanoviæ. 2011. Long term effects of different soil tillage systems on maize (*Zea mays* L.) yields. *Plant Soil Environ.* 57: 2011(4) : 186–192.

Wise, R.M. and Oscar, J. 2008. Bioeconomic meta-modelling of Indonesianagroforests as carbon sinks. 2008 Conference (52nd). February 5-8, 2008. Canberra, Australia 6772. Australian Agricultural and Resource Economics Society.