International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
www.chemijournal.com
IJCS 2021; 9(2): 528-530

Received: 10-01-2021
Accepted: 19-02-2021

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Yield performance of different crops under *Dalbergia sissoo* based agrisilviculture system in central India

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Abstract
India is developing and Growing country therefore their needs and demands will be high. Basically India are agriculture country but that time land sacristy and food sacristy will be create due to growing population. India is one of the most densely populated country of the world 121 million peoples having live in 329 million ha. Geographically area which population density of 382 person per sq. km (censes of India 2011) this situation create heavy pressure on land for food, timber, fuel and industrial wood etc. and The statistically analyzed data showed that the wheat crop was find significantly higher grain yield production growing with *Dalbergia sissoo* (T_3: 1838.78 Kg ha^{-1} yr^{-1}) than mustard (T_1 645 Kg ha^{-1} yr^{-1}) and gram (T_2 344.78 Kg ha^{-1} yr^{-1}) during 2017-18 respectively. In open condition the wheat crop was found higher grain yield than mustard and gram during the year.

Keywords: Agrisilviculture, *Dalbergia sissoo*, agroforestry

Introduction
Dalbergia sissoo is a medium to large sized tree belonging to family – Leguminosae and subfamily *Papilionioideae.* It attains a height upto 30m.This genus has about 300species of tropical and sub-tropical timber tree species. It is having multiple uses such as fuel, wood, fodder, shade, and nitrogen fixing ability. The species occur throughout the Sub-Himalayan tract and outer Himalayan valleys from Indus to Assam, usually upto 900m and occasionally ascending to 1500m**.** Agroforestry is the one of option to Fulfill and manage the land sacristy and people needs**.** The different alternatives of climate change mitigation, agroforestry is the best and can sustain all over the world if we manage in a proper manner. Agroforestry is a climate-smart production system and considered more resilient than mono-cropping in mitigating climate change (Charles *et al*, 2014). The agrisilviculture (tree+crop) system is more productive and sustainable than agriculture. Agricultural crops grown with agroforestry trees relatively poor yielder due to effect of shade. Shade intensity has strong negative effects on the performance of under story crops (Singh *et al*., 1993) [12]. Light is a critical factor affecting the performance of field crops under agroforestry intervention. Pruning has become an essential practice for reducing both above and below ground competition with associated crops (Fownes and Anderson, 1991; Sinclair *et al.*, 1998) [3, 13]. Wheat can be grown successfully in open condition and in association with *Dalbergia sissoo*. Management practices are very necessary to get optimum production from an agrisilviculture system.

Material and Methods
The present Experiment was conducted in 19 years old plantation of Dalbergia sissoo at new Dusty Acre Farm, Department of Forestry, JNKVV, Jabalpur during 2017-18. Jabalpur is situated at 23°9' North latitude and 79°58' East longitudes with an altitude of 411.78 meters above the mean sea level. The climate of the locality is characterized as typically semi-humid and tropical, which is featured by hot dry summer and cool dry winter. It is classified as “Kymore Plateau and Satpura Hills" agro-climate zone and is broadly known as rice- wheat crop zone of Madhya Pradesh and their average annual rainfall is 1315 mm which is mostly received between mid-June to the end September with occasional winter showing during December months.

The soil of the experimental field was clay sandy loam in texture, neutral in reaction (pH 7.00) with high organic carbon (1.52%), available Nitrogen (385.31 kg ha-1), Phosphorous (69.12 kg ha-1) and potassium (355.98 kg ha-1) and Electrical conductivity (0.26 dS/m2). During the growing month of the crop (October to April 2017-18) Maximum temperature (38.9 °C) was recorded in April and minimum temperature (6.6 °C) in December relative humidity ranged between 54.8 to 87.4% in morning and 24.1 to 40.4% in evening.

Experimental details

There are 7 main treatments (T_1- *Dalbergia sissoo* + mustard), (T_2- *Dalbergia sissoo* + Gram), (T_3- *Dalbergia sissoo* + Wheat), (T_4- *Dalbergia sissoo*) and (T_5-Mustard), (T_6-Gram), (T_7-Wheat) are Open - No tree (Crop only) the Tree spacing 5 m x 5m are Replicated in 3 times under RBD (Randomized Block Design). The Gross plot size is 5 m x 5 m Net plot size 4.5 m x 4.5 m Seed rate (Recommended dose)

Intercrop	Spacing	Seed Rate	Fertilizer dose
Mustar	45 cm	5 kg ha^{-1}	N:P:K(4:2:1)
Gram	45 cm	71 kg ha^{-1}	N:P:K(1:2:1)
Wheat	22.5 cm	100 kg ha^{-1}	N:P:K(4:2:1)

Methodology for recording observations

Grain yield (Kg ha $^{-1}$)

After winnowing and cleaning the grains from each net plot, it was weighed on a spring balance. The grain yield per hectare was obtained by multiplying the net plot yield by the converting factor {10,000 dividing by net area (m^2) of plot}. The yield was expressed in kilograms per hectare.

Straw yield (Kg ha^{-1})

The straw yield of each plot was determined by substracting the grain yield from the biological yield of the respective plot. The values so obtained were converted into straw yield per ha by multiplying with net plot yield by the converting factor {10,000 dividing by net area (m^2) of plot}. The yield was expressed in kilograms per hectare.

Harvest Index

Harvest index is expressed as the ratio of economic yield (grain yield) to the total biological yield (grain yield + straw yield) and expressed in percentage. It was calculated as per the formula proposed by Nichiporovich (1967).

$$\text{Harvest Index (\%)} = \frac{\text{Economic yield}}{\text{Biological yield}} \times 100$$

Result and Discussion

Grain yield

The statistically analyzed data presented in Table 1 and Fig. 1 showed that the wheat crop was find significantly higher grain yield production growing with *Dalbergia sissoo* (T3: 1838.78 Kg ha^{-1} yr^{-1}) than mustard (T1 645 Kg ha^{-1} yr^{-1}) and gram (T2 334.89 Kg ha^{-1} yr^{-1}) during 2017-18 respectively. In open condition the wheat crop was found higher grain yield than mustard and gram during the year. The probable reason higher yield under open condition is that, open condition received maximum sunlight, result produce maximum number of growth and yield characters. The reduction in growth and yield of field crops grown with tree due to adverse effect of tree species in agroforestry system than their pure cropping. Similar results have also been reported by Puri *et al*. (2001) [7]; Shamughavel *et al*. (2001) [11]; Islam *et al*. (2006) [5]; Karwar *et al*. (2006) [6]; Dhillon *et al*. (2007) [2].

Straw yield

The statistically analyzed data presented in table 1 and Fig.1 showed that the wheat crop was find significantly higher straw yield production growing with *Dalbergia sissoo* (T3: 4476. Kg ha^{-1} yr^{-1}) than mustard (T1 2572.41 Kg ha^{-1} yr^{-1}) and gram (T2 1273.13 Kg ha^{-1} yr^{-1}) during 2017-18 respectively. In open condition the wheat crop was found higher straw yield than mustard and gram during the year. It was also suggested by Prasad *et al*. (1997) [8] that in an agroforestry system, reduction in intercrop yields could be minimized by proper management practices such as pruning of tree component.

Harvest index

The perusal of data presented in table 1 and Fig.1 showed that the second year found higher harvest index than first year. The harvest index of wheat crop was find significantly higher growing with *Dalbergia sissoo* (T3: 29.16 Kg ha^{-1} yr^{-}) than gram (T2 20.84 Kg ha^{-1} yr^{-1}) and mustard (T1 20.05 Kg ha^{-1} yr^{-1}) during 2017-18 respectively. In open condition the wheat crop was found higher harvest index than mustard and gram during the year.

Table 1: The statistically analyzed data presented

Land use systems	Grain Yield of crops (Kg ha^{-1} yr^{-1})	Straw Yield of crops (Kg ha^{-1} yr^{-1})	Aboveground Biomass production(Kg ha^{-1} yr^{-1})	Harvest Index
D.sissoo+Mustard T1	645	2572.41	3217.41	20.05
D.sissoo+Gram T2	334.89	1273.13	1608.02	20.84
D.sissoo+Wheat T3	1838.78	4476.13	6314.9	29.16
Dalbergia sissoo T4	692.77	2794.9	3487.67	19.87
Mustard T5	391.74	1318.53	1710.28	22.90
Gram T6	2067.5	5260.58	7328.08	28.92
Wheat T7	995.1133	2949.28	3944.39	23.62
Mean	37.5	374.35	398.96	1.15
SEm±	111.87	1116.67	1190.20	3.44
CD at 5%	645	2572.41	3217.41	20.05

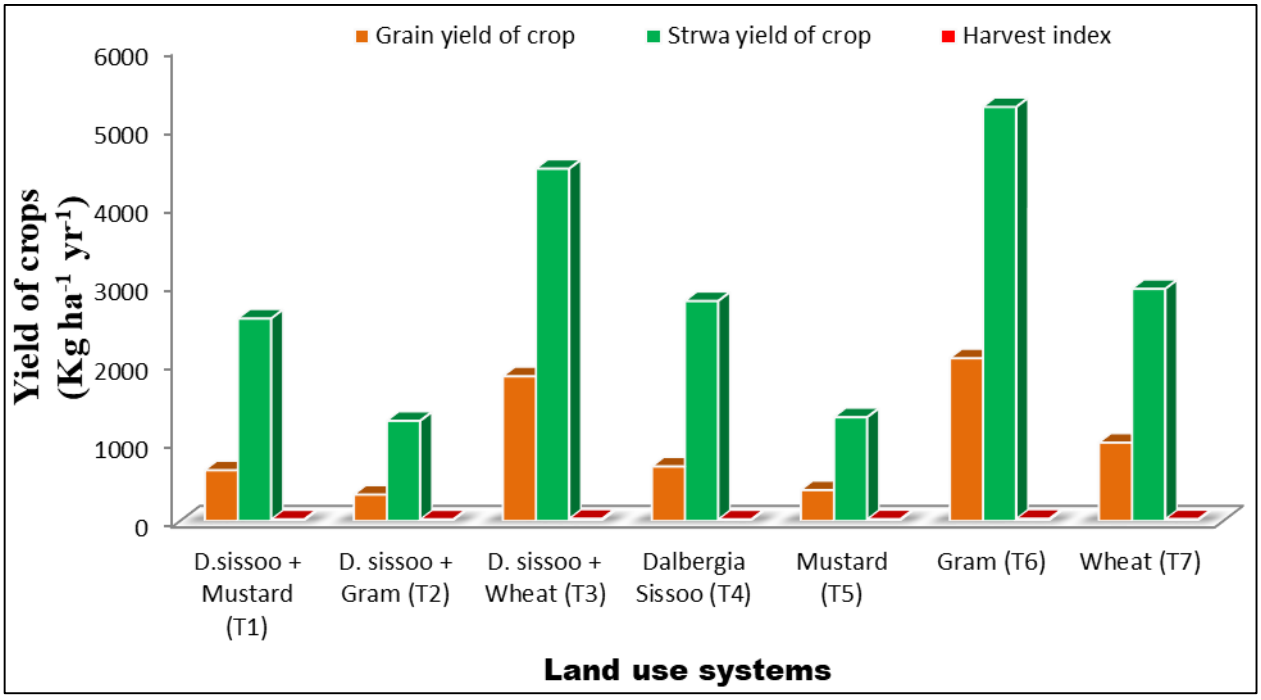

Fig 1: Land use systems

Conclusion

Dalbergia sissoo is a leguminous tree which provide favorable growing environment for the under storied crop. In this experiment the growing of wheat found higher grain and straw yield than the gram and the mustard crop.

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