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Correlation Analysis of Yield with Yield Attributing Characters and Soil Properties of *Cajanus cajan* (Arhar) in Silvi-horti-agri System

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ABSTRACT

Background: Pulses are the major source of protein and is widely used to fulfill protein requirement of the growing population. Perennial pigeon pea [*Cajanus cajan* (L.) Millsp.] is a predominant crop grown in kharif season, also known as Red gram, Arhar or Tur. The present study aimed to correlate yield of *C. cajan* with growth and soil properties under agroforestry system in Madhya Pradesh.

Methods: An experiment was conducted to assess the yield of *Cajanus cajan* under agroforestry system at Tropical Forest Research Institute, Jabalpur during the year 2020-2021. In this study *Cajanus cajan* (Arhar) intercropped with *Pterocarpus marsupium* (Bijasal) and *Psidium guajava* (guava) under silvi-horti-agri system. During study period, growth parameters such as height, no. of pods and no. of branches of *C. cajan* were recorded and soil properties such as Soil pH, EC, Nitrogen, Phosphorus and Potassium were also estimated before sowing and at the time of harvesting of agriculture crop.

Result: Study revealed that yield has highly significant positive correlation with an average plant height (0.4735), no. of pods/plant (0.2558) and no. of branches/plant (0.3765), another result shows that yield has highly significant correlation with organic carbon % (0.7966), nitrogen content of soil (0.3049), Potassium (0.3036), Phosphorus (0.6244) and has negative correlation with pH of soil (-0.9336) and EC (-0.8740) at 5% level of significance. Similarly, correlation of yield with soil parameters at the time of harvesting and the results revealed that the yield has positive correlation with organic carbon % (0.5277), nitrogen content of soil (0.1102), Potassium (0.2324), Phosphorus (0.7118) and has negative correlation with pH of soil (-0.4861) and EC (-0.3853) at 5% level of significance.

Key words: *Cajanus cajan*, Correlation analysis, *Psidium guajava, Pterocarpus marsupium*, Silvi-horti-agri system, Soil properties.

INTRODUCTION

Agroforestry is a land use system that integrates trees, crops and animals in a way that is scientifically proven, ecologically desirable, practically feasible and socially acceptable to the farmers (Nair, 1979). Besides, tree based land use systems offer several ecosystem services which benefit the agricultural practices by improving soil fertility, maintains soil moisture, reduce soil erosion, reduce water run off from surface soil and water conservation, enhancement of water quality, carbon sequestration and biodiversity conservation (Jose, 2009; Chittapur and Patil, 2017).

Horticultural production in rainfed and semi arid conditions has lesser risk unlike that of seasonal agricultural crops and provides stability to the farmer's income. Production of fruits and agriculture crops in semi arid condition would make nutritive food available to under nourished people (Rao and Murthi Sankar, 2008). It was also noticed that runoff percentage lowest under agri-horticulture systems compared to fragile ecosystem, apart from generation of off season employment. Samara *et al.* (2010) also reported that horticulture provides tremendous opportunities with high potential for enhancing nutrition, employment, income and livelihood securities in rainfed areas through vertical expansion of area under fruit crop.

Pulses are the major sources of protein and widely used to ensure protein requirement of the growing population. Perennial pigeon pea [*Cajanus cajan* (L.) Millsp.] is a predominant crop grown in kharif season, also known as Red gram, Arhar or Tur and consumed throughout the India. India is the largest producer and processor of pulses in the world (www.indiamicrofinance.com).

C. cajan is the IInd important pulse crop after the gram. Out of the total production of pulses (9.31 million tones), 4.04 million tones is only from *C. cajan* (https://pib.gov.in, 2020-21 - First advance estimate).

Honnayya *et al.* (2020) investigated the yield of *C. cajan* in *Azadirachta indica* (neem) based agroforestry system in semi arid tropics and found that at short distance from the tree lines, growth attributes of *C. cajan* were significantly

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reduced on western and eastern directions of north-south tree line compared to northern and southern directions of east-west tree line, with significantly higher number of pods per plant, seed yield per plant, seed yield and stalk yield (74.00, 24.80 g plant^{-1}, 780 kg ha^{-1} and 1970 kg ha^{-1}), respectively were recorded in control and number of pods (43.33 per plant), seed yield (14.36 g/plant), seed yield (376 kg ha^{-1}), stalk yield (1283 kg ha^{-1}) and harvest index (0.23) were recorded closer to the tree line. Rajput and Rawat (2019) studied on influence of nutrient management practices in pigeon pea and cluster bean intercropping system and found that sole pigeon pea and cluster bean recorded significantly higher seed and stalk yield, harvest index, number of pods/plant, test weight, protein content, protein yield, dry matter/plant. Bohra *et al.* (2020) evaluated seed yield per plant of pigeon pea shown significant positive correlation with plant height, pods per plant, pod length and harvest index both at phenotypic and genotypic level. Pods per plant and pod length had shown high positive direct effects on seed yield per plant at both genotypic and phenotypic level under. Anusha, (2012) reported that Agroforestry systems are profitable than that of monocropping systems.

Farmers prefer the trees on the bunds with varying density. Among the pulses, *C. cajan* is more successful under rainfed agro-ecosystem grow neither sole or intercropped with perennial tree crops in agroforestry system. Hence, the present study was undertaken with the hypothesis to analyse yield of *C. cajan* correlation with growth and soil properties under agroforestry system in Madhya Pradesh.

MATERIALS AND METHODS

The experiment was carried out in demonstration plot of Tropical Forest Research Institute, Jabalpur district (Madhya Pradesh). The study area lies between 23°6′0.32″N latitude and 79°59′17.72″E longitude. Annual rainfall varies from 1000 mm - 1600 mm and temperature varies from 7.5°C - 8°C minimum and 35.5°C - 42.5°C maximum. The soil type was sandy loam with pH values ranging from 6.0 to 8.0.

Collection of Soil sample and estimation of Physico - Chemical parameters

The soil samples were collected from each replication at 0-15 cm depth of soil surface during initial stage of crop *i.e.* before sowing and at the time of harvesting of crop to assess the nutrient status of soil by following standard methods of soil chemical analysis (Table 1).

Field preparation

Before sowing field was prepared by pruning of lateral branches of tree to reduce the shade to companion crop and basal dressing of FYM was done at the rate of 15 tons ha^{-1} as per recommendation by agriculture practice.

Cultivation of *C. cajan*

The seeds of *C. cajan* (Variety-Durga) was sown in *Kharif* season *i.e.* last week of June, 2020 at spacing of 60 cm × 30 cm as both sole as well as intercrop in between *P. marsupium* (10 m × 8 m) and *P. guajava* (5 m × 8 m). The experiment laid down in three replications and the area of each replication was 30 m × 12 m, area of sole crop was 30 m x 8 m and total area was 30 m × 44 m (Fig 1). Weeding was done after 3rd and 5th weeks of sowing the crop. The plot was maintained by irrigation three times.

RESULTS AND DISCUSSION

Biometric observations like plant height, number of pods, number of branches per plant of *C. cajan* were recorded during the time of harvesting at different levels of spacing and different combination treatments and following results were obtained.

Growth attributes of *C. cajan*

Comparative growth attributes of *C. cajan* as shown in Fig 2 revealed that average height of *C. cajan* plants was more (211.34 cm) under Agroforestry system as compare to sole *C. cajan* (192.70 cm), average number of pods per plants were also more (63.10) under Agroforestry system in comparison with sole *C. cajan* (38.52), similarly average number of branches per plants was higher (10.85) in Agroforestry system as compared to sole cropping (10.83). The results are in agreement with those reported by Chundawat and Gautam, 1993 that some time tree shade gives positive impact on growth and grain yield of intercrops and Doddabasawa *et al.* (2017) assessed neem based agroforestry system in Karnataka and observed no difference in grain yield, biomass yield and harvest index among agroforestry systems. Here in our study tree shade has lesser effect on the growth of *C. cajan* and higher production was obtained under Agroforestry system as compared to sole crop of *C. cajan.* Intercultural operations

Table 1: Soil chemical analysis methods.

Soil chemical test	Methods adopted
Soil pH	Combined glass electrode pH (Jackson, 1973)
Soil electrical conductivity (mS/cm,)	Conductivity meter (Piper, 1950)
Soil organic carbon %	Walkey and black method, 1934
Available nitrogen (kg ha^{-1})	Subbiah and Asija, 1956
Available phosphorus (kg ha^{-1})	(Olsen *et al.*, 1954)
Available potassium (kg ha^{-1})	Merwin and Peech (1951)

like irrigation, FYM application and proper weeding were done during cropping season.

Soil nutrient status

Data of soil chemical analysis revealed that in intercropping, soil condition of the field improved compared to that of sole cropping of *C. cajan.* Litter decomposition of *P. marsupium* and *P. guajava* plants increases organic carbon% in intercropping by 0.05% while in sole cropping organic carbon % also shows slight increase (0.02%). In case of phosphorus, value of phosphorus increased by 5.02 kg ha^{-1} and value of Nitrogen shows increasing trend with 13.57 kg ha^{-1} in intercropping but potassium shows decreasing trend in both the systems. Soil pH was also increased in both the system but improvement of soil pH was higher in intercropping as compared to sole. Pareek and Sharma (1993) noted that fruit trees like tamarind in pastoral system are able to fix nitrogen in soil. Similarly, improvement in soil was reported by (Kumar *et al*., 2009) in Aonla based horti-pastoral system. Kumar and Shukla (2010) also reported nutritional buildup of soil in association with trees was better in all respect *viz*. organic carbon, available nitrogen, phosphorus and potash as compared to sole pasture crop in 10 years old grown plantation.

Correlation studies

As depicted in Table 2 correlation studies based on field observations, described zero order correlation of yield with different yield contributing parameters. Results of present study showed that, yield has highly significant positive correlation with average plant height (0.4735**), no. of pods/plant

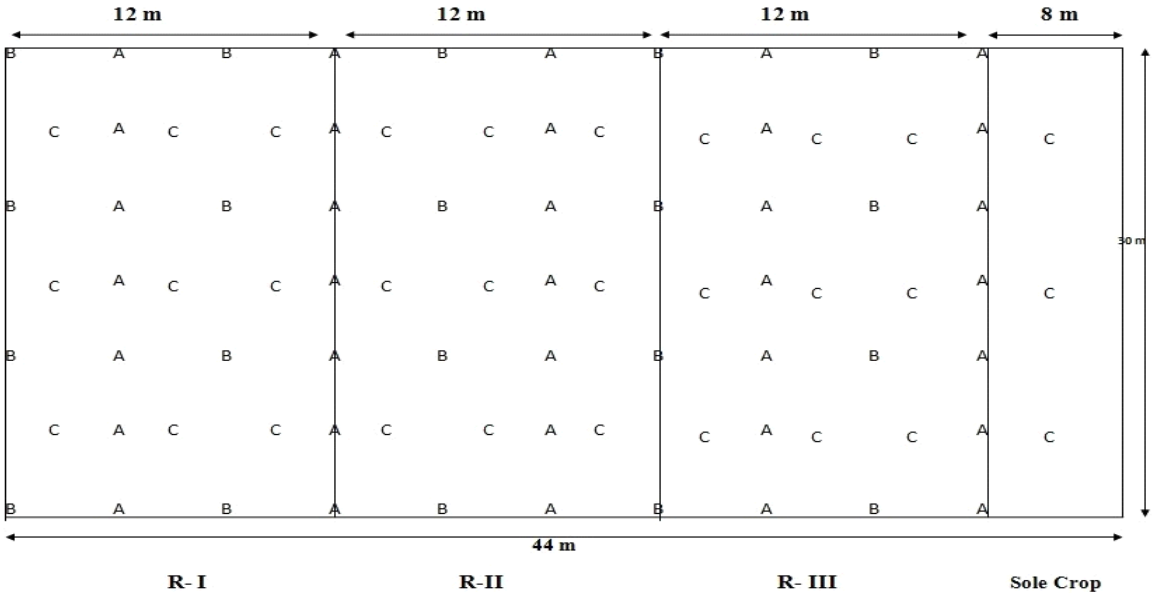

Fig 1: Layout of demonstration plot of Silvi- horti - agri system (*Psidium guajava* + *Pterocarpus marsupium* + *Cajanus cajan*). Where, A= *Psidium guajava*, B= *Pterocarpus marsupium*, C= *Cajanus cajan*.

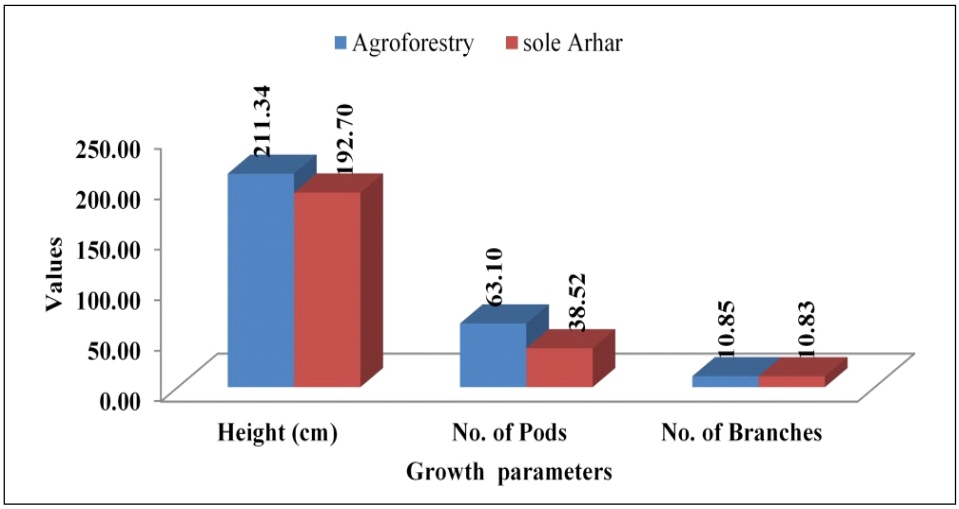

Fig 2: Comparative growth attributes of *Cajanus cajan* under Silvi-horti-agri system.

(0.2558**) and no. of branches/plant (0.3765**) at 5% level of significance. It was further reported that average plant height has significant positive correlation with respect of no. of branches per plant (0.9297**) and also with no. of pods per plant (0.7074**) at 5% level of significance. Similarly no. of pods per plant has highly significant positive correlation with no. of branches per plant (0.4111**).

Table 3 revealed the zero order correlation of yield with various soil parameters before sowing of crop. Result shows that yield has highly significant correlation with organic carbon% (0.7966), nitrogen content of soil (0.3049), potassium (0.3036), phosphorus (0.6244) and has negative correlation with pH of soil (-0.9336) and EC (-0.8740) at 5% level of significance. Similarly, Table 4 shows the zero order correlation of yield with soil parameters at the time of harvesting and the results revealed that the yield has positive correlation with organic carbon % (0.5277), nitrogen content of soil (0.1102), potassium (0.2324), phosphorus (0.7118) and had negative correlation with pH of soil (-0.4861) and EC (-0.3853) at 5% level of significance.

Regression studies

Table 5 and Fig 3, 4 and 5 describes linear regression equation of yield (g/plant) with average plant height (cm), no. of pods per plant and no.of branches per plant. During present study, regression analysis revealed that, the linear increase in yield was predicted with average plant height (m), no. of pods per plant and no.of branches per plant, the increase in yield could be predicted by 0.02, 0.0092 and 0.1634 respectively with the increase of one unit of each parameter.

Table 2: Zero order association of average plant height, no. of pods/plant and no. of branches with yield under Silvi-horti-agri system.

Variables		Average plant height (cm)	No. of pods /plant	No. of branches /plant	Weight of seeds /plant (g) (Yield)
		X1	X2	X3	Y
Average plant height (cm)	X1	1.0	0.7074**	0.9297**	0.4735**
No. of pods/plant	X2		1.0	0.4111**	0.2558**
No. of branches/plant	X3			1.0	0.3765**

Note: ** Sign indicates 5% level of significance.

Table 3: Zero order association of soil parameters (Before Sowing) with yield under Silvi-horti-agri system.

Variables		Organic carbon %	Nitrogen	Potassium	Phosphorus	pH	EC	Yield
		X1	X2	X3	X4	X5	X6	Y
Organic carbon %	X1	1.0	0.5597	0.5598	0.5306	-0.9577	-0.4538	0.7966
Nitrogen	X2		1.0	1.0000	0.8388	-0.5144	-0.2748	0.3049
Potassium	X3			1.0	0.8374	-0.5138	-0.2726	0.3036
Phosphorus	X4				1.0	-0.6457	-0.7377	0.6244
pH	X5					1.0	0.6893	-0.9336
EC	X6						1.0	-0.8740

Note: Values at 5% level of significance.

Table 4: Zero order association of soil parameters (at the time of harvesting) with yield under Silvi-horti-agri system.

Variables		Organic carbon %	Nitrogen	Potassium	Phosphorus	pH	EC	Yield
		X1	X2	X3	X4	X5	X6	Y
Organic carbon %	X1	1.0000	0.7436	-0.3095	0.5074	-0.3888	-0.6127	0.5277
Nitrogen	X2		1.0000	0.0961	0.6011	0.3197	0.0253	0.1102
Potassium	X3			1.0000	0.6544	0.6791	0.8080	0.2324
Phosphorus	X4				1.0000	0.2189	0.1901	0.7118
pH	X5					1.0000	0.9391	-0.4861
EC	X6						1.0000	-0.3853

Note: Values at 5% level of significance.

Table 5: Linear regression equation of yield (g) on average plant height (cm), no. of pods per plant and no.of branches per plant along with R^2.

Variable	$\hat{Y}$ = a+bX	Coefficient of determination (R^2)
X1: Average plant height (cm)	$\hat{Y}$ = 5.0891+0.02X1	0.2242
X2: No. of pods per plant	$\hat{Y}$ = 8.6835+0.0092X2	0.0654
X3: No. of branches per plant	$\hat{Y}$ = 7.2325+0.1634X3	0.1418

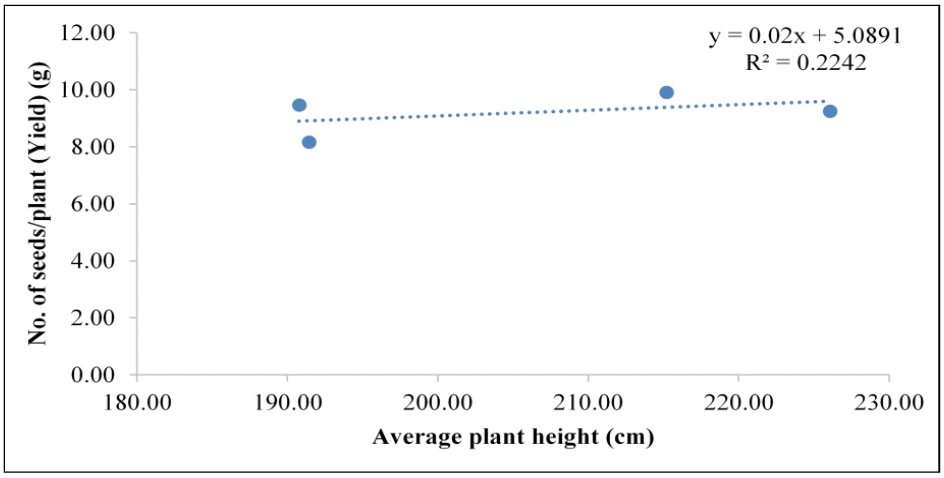

Fig 3: Regression equation of yield (g) with average plant height (cm) under Silvi-horti-agri system.

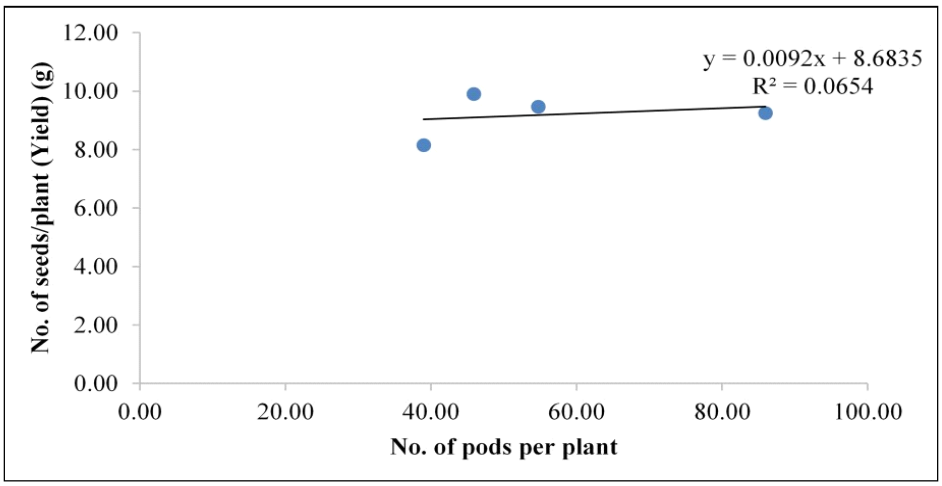

Fig 4: Regression equation of yield (g) with no. of pods per plant.

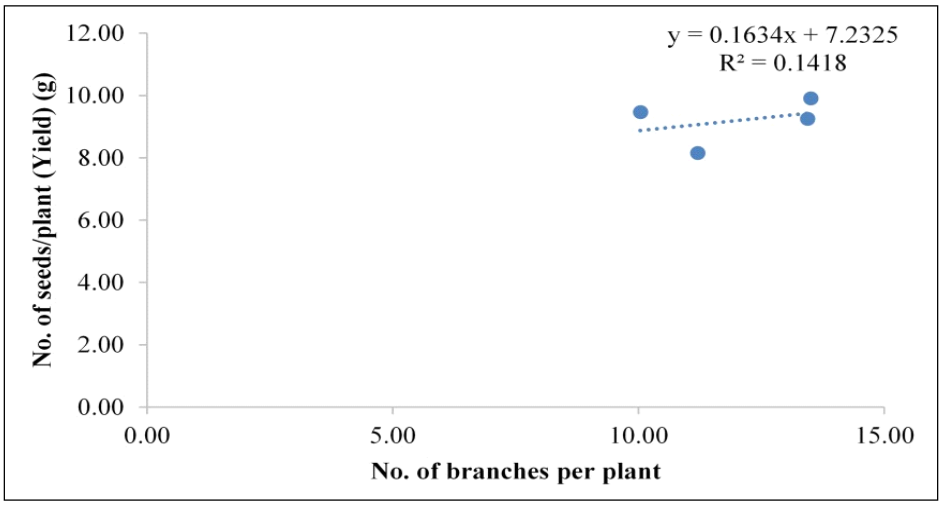

Fig 5: Regression equation of yield (g) with no. of branches per plant.

CONCLUSION

Thus, the study suggests that Agroforestry landuse system proved most compatible with leguminous crop like *C. cajan* in terms of maximum productivity which will be a viable option for doubling the farm income by utilizing optimum resources during present scenario of climate change besides conserving commercially valuable medicinal tree like *P. marsupium* and most preferred fruit yielding plant *i.e. P. guajava* by the farmers.

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