Original Research Article

CORRELATION STUDIES ON DIFFERENT GROWTH PARAMETER OF SPICE CROPS UNDER POPLAR BASED AGROFORESTRY SYSTEM

Abstract

The Present study was carried out to estimate the correlation of intercrop *viz.*,Fennel, Ajowain, Coriander, Fenugreek, Mentha, Kalonji, Chilli and Cumin under Poplar-basedagroforestry system. Experiment was conducted under 15 years old existing poplar based agri-silviculture system using Randomized Block Design (RBD) with three replications and 8 treatments in central part of state U.P. The treatments used under experimentation are (C_1) Fennel, (C_2) Ajowain, (C_3) Coriander, (C_4) Fenugreek, (C_5) Mentha, (C_6) Kalonji, (C_7) Chilli, and (C_8) Cumin. The significantly positiveand negativecorrelation was recorded on parameter viz. Plant Height, No. of Branch, No. of leaves, No. of Umbels / plant, No. of Umblets/ Umbels, No. of Seed / Umblets, test Weight and yield.The findings of present study will be benefits to farmers and agriculture professionals in estimating correlation of various yield and growth parameters under Poplar tree under certain management practices to get higher returns.

Key words: Correlation, Agroforestry system, Poplar, Intercrop, Agri-silviculture

INTRODUCTION

Correlation matrix study helps in assessment of association of parameters over others. The intensity and trend ofassociation among characters may be estimated by correlation coefficients of correlations parameters. Agroforestry is an approach that integrates trees into farming systems, and allows for the production of trees and crops or livestock from the same piece of land in order to obtain economic, environmental, ecological, and cultural benefits (Thevathasan*et al.*, 2004). Diversification of existing farming systems by developing suitable agroforestry models seems to be the need of the day to supply ever increasing demand for diversified products. Traditional agro-forestry system had its origins in developing nations where high population densities coupled with scarce land resources have required that concurrent food and wood production may be produced on the same land base with little compromise on principal of sustainability.Poplar is the very prominent species in plantation forestry as well as in natural forests north-western state of India. Its natural population is small and found only in the mountains with few indigenous species. As an exotic species *(Populous deltoides*), it acquires great role afforestation/reforestation programmes, agro-forestry and conservation activities.

According to India country report on poplar and willow (Anonymous 2012), area under poplar outside the forest in India is estimated 3,12,000 ha. The annual return from poplar at current market rates are estimated to be around one Rs. 60,000-80,000 rupees acre^{-1} year^{-1}, which is much higher than any other on-farm intervention (Dhiman, 2012). Poplar is normally planted and grown under wide spacing accommodating 400 to 500 tree ha^{-1}.Spices are integral part of human daily life, especially in Indian society; in tradition, food, aroma, health and economy and every positive development in spices improves the quality-of-life world over. India is the largest producer of spices with an annual production of 6.1 million MT during 2014-15 from an area of 3.3 million hectares. Black pepper, ginger, turmeric, cardamom and tree spices such as nutmeg, cinnamon, garcinia and tamarind are the tropical spices of importance in Indian context.

Gill *et al.*, (2008) reported that inter cropping of lemon grass, Tagetesminuta, turmeric, celery, coriander, fennel, dill reed, fenugreek, mentha species and mustard with poplar trees increased the dbh and height of poplar tree. Malik et al. (2011) have conducted research on bamboo based agroforestry system in Jharkhand(Dhanyashri*et al.*, 2020).Coriander, cumin, fennel and fenugreek are important seed spices and mint is an herbal spice of importance. Garcinia, black cumin, ajowain, saffron, mint, oregano, lavender, star anise are considered as future crops among the spices. India has been a traditional producer, consumer and exporter of spices in the world and almost all states in the country produce one or the other spices.The spices constitute an important group of agricultural commodities and play a significant role in our national economy. The seed spices possess industrial importance and are used in cosmetics, perfumery and pharmaceutical preparations. The export of seed spices annually is to the tune of about 83,550 tonnes against requirement of 1,55,000tonnes in the world market. The export can be increased if in addition to major seed spices crops (coriander, fennel, cumin, and fenugreek), the minor seed spices crops (ajowan, dill, celery, nigella, anise) are also given importance (Malhotra and Vashishtha, 2007).Fennel (*Foeniculumvulguare mill.)* is a highly cross pollinated and very important seed spice crop exhibiting 82.2% to 91.4% natural out crossing. Fennel seeds are having medicinal importance as carminative, cardiotonic, stimulant, vermicide and lactagogue(Lal, 2014). India is the largest producer, consumer and exporter of spices and spice products. Fennel had very little share to total production of spices.

Coriander being an ancient herb and spice is imperative owing to its accessibility, low cost and allied therapeutic claims (Kansal, 2011). Fenugreek is one of the important winter season leguminous crops cultivated mainly in Northern India, where Rajasthan is the major producer of fenugreek, followed by Gujarat and Uttar Pradesh. Coriander plant is originated from the Mediterranean and Middle Eastern regions and known as medicinal plants. It contains an essential oil (0.03 to 2.6%) (Nadeem*et al.*, 2013); (Dhanyashri*et al.*, 2020).

Ajowain (*Trachyspermumammi* L.) well known as carom seed or Bishop's weed belongs to family Apiaceae and is a native of Egypt (Sayre, 2001). It is a popular minor seed spice crop having good medicinal value in India.The large scale commercial cultivation of Mentha in U. P. is done in tarai belt namely Moradabad, Badaun, Rampur and Bareilly districts and in central part namely Barabanki, Sitapur and Lucknow districts. Total sowing area of mentha crop in whole U. P. was about 264657 hectare and production of mentha oil was 26,469 MT in the year 2012-13. It is also produced by countries like Persia, Iran, Egypt, Afghanistan and Pakistan. During 2007–08, 1,120 tonnes of Ajowain seed was produced from 19,590 hectare in India (Meena *et al.,* 2009).Chilli (*Capsicum annum* L.) is one of the important vegetable cum commercial spice crop grown in Andhra Pradesh, which ranks first in production and productivity in India. The Solanaceous group of vegetables generally takes up large amounts of nutrients depending upon the quantity of fruit and dry matter they produce, which is mostly influenced by a number of genetic and environmental variables (Prasad *et al.,* 2009).Cumin (*Cuminum cyminum* L.) is short duration seed spice crop of arid and semi-arid regions of India. Due to low requirement of inputs and sensitive to slight change in climatic condition and higher market price, it is termed as low volume with high value but risky crop(Lal&Naugraiya 2019). Spices production is becoming more popular under different agroforestry models, especially in Poplar tree. Considering increasing demand and suitability of various spice crop, present paper is focusing on correlates of various parameters of spices under poplar-based agroforestry system has been presented in this paper.

Materials and Methods

Present investigation was carried out atForest research Nursery of College of Forestry, SHUATS in8-10 years old existing poplar plantation having spacing of 3m × 6mduring Rabi season 2017-18 and 2018-19.The characteristics of the soil are sandy loam in order to Inceptisol soil.Study areais situated at an elevation of 78 meters above mean sea level at 28.87^{o}N latitude and 81.15^{o}E Longitude and has tropical to sub-tropical climate with extremes of summer and winter. During the winter months especially December and January, temperature drops down to as low as 5^{o}C while in the summer temperature reaches above 45^{o}C, hot scorching winds are a regular feature during the summer whereas there may be an occasional spell of frost during the winter. The annual rainfall is 1100mm mostly during July to September, with a few occasional showers during the winter months. The weekly average data on weather condition during the

experimentation period are presented in table1. The specific and recommended package of cultivation practices applied for each selected spice crop. Data pertaining to correlation matrix of spice crops under poplar based agroforestry system were recorded carefully and subjected to statistical analysis using OPSTAT and presented in different tables.

Table 1:Meteorological data collected during study period (November 2017 - April 18)

Month	Temperature ^{o}C		Rainfall	Relative Humidity (%)	
	Max.	Min.		7.00AM	2.00 PM
Nov-17	30.59	14.99	0.00	89.10	40.27
Dec-17	27.59	9.74	0.00	93.00	42.29
Jan-18	25.75	8.46	0.00	93.68	47.65
Feb-18	30.24	11.69	6.60	88.32	42.96
Mar-18	36.26	18.84	0.00	82.52	36.52
Apr-18	38.16	24.13	24.40	82.27	40.87

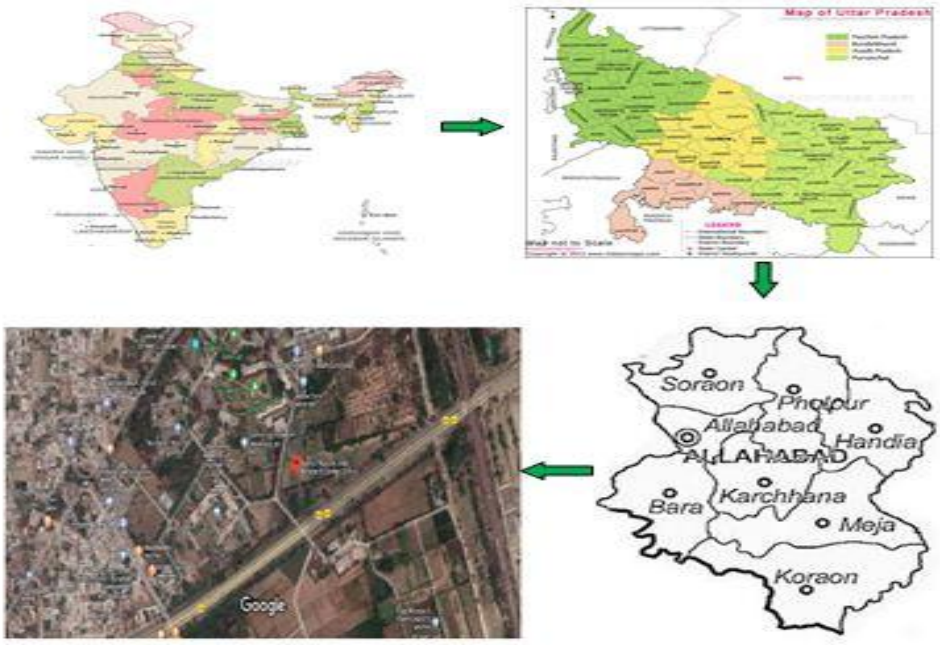

Fig .1 Location map of the research site

Results and Discussions

The results of the investigation on correlation matrix of spice crops under poplar based agroforestry system have been presented in tables and discussed accordingly under various heads as below.

Correlation between different observations of Fennel crop under poplar first year

Table 2 depicted the fennel of plant height shows positively correlated with no. of umblets/umbels (0.241), no. of seed/ umblets (0.015), test weight (0.154), yield (0.119) andnegatively correlated with, no. of branch (-0.397), no. of leaves (-0.411), no. of umbels/plant (-0.128). Fennel no. of branch shows positively correlated with no. of leaves (0.066), no. of umbels/plant (0.034), no. of umblets/umbels (0.223), test weight (0.073) and negatively correlated with, no. of seed/umblets (0.416), yield (-0.211). Fennel number of leaves shows positively correlation with no. of seed/umblets (0.186) and negatively correlation with, number of umbels/plant (-0.256), no. of umblets/umbels (-0.249), test weight (-0.173), yield (-0.077). Fennel no. of umbels/plant shows positively correlation with no. of seed/umblets (0.017), test weight (0.108) and negatively correlation with, no. of umblets/umbels (-0.271), yield (-0.318). Fennel no. of umblets/umbels shows positively correlation with test weight (0.163) and negatively correlation with, no. of seed/umblets (-0.009), yield (-0.010). Fennel no. of seed/umblets shows negatively correlation with, test weight (-0.316) and yield (-0.144). Fennel test weight shows negatively correlation with, yield (-0.209).

Table 2: Correlation between different observations of Fennel crop under poplar first year

	Plant Height	No. of Branch	No. of Leaves	No. of Umbels / plant	No. of Umblets/ Umbels	No. of Seed / Umblets	Test Weight	Yield
Plant Height	1.000							
No. of Branch	-0.397	1.000						
No. of leaves	-0.411	0.066	1.000					
No. of Umbels / plant	-0.128	0.034	-0.256	1.000				
No. of Umblets/ Umbels	0.241	0.223	-0.249	-0.271	1.000			
No. of Seed / Umblets	0.015	-0.416	0.186	0.017	-0.009	1.000		
Test Weight	0.154	0.073	-0.173	0.108	0.163	-0.316	1.000	
Yield	0.119	-0.211	-0.077	-0.318	-0.010	-0.144	-0.209	1.000

Correlation between different observations of Ajowain crop under poplar first year

Table 3 depicted the Ajowain of plant height shows positively correlated with Leaves (0.438), no. of seed/ umblets (0.208) and negatively correlated with, no. of branch(-0.282), no. of umbels/plant (-0.007), no. of umblets/umbels (-0.069), test Weight (-0.306), Yield (-0.021). Ajowain no. of branch shows positively correlated with no. of leaves (0.122), No. of Umblets/ Umbels (0.469),No. of Seed / Umblets (0.141), test weight (0.295) and negatively correlated with, No. of Umbels / plant (-0.158), yield (-0.310). Ajowain leaves shows positively correlation with No. of Umbels / plant (0.300), test Weight (0.199) and negatively correlation with number of correlation with, no. of umblets/umbels (-0.121), No. of Seed / Umblets (0.036), Yield (-0.281). Ajowain no. of umbels/plant shows positively correlation test Weight (0.121) and negatively correlation with, no. of umblets/umbels (-0.121), No. of Seed / Umblets (-0.036), yield (-0.281). Ajowain no. of umblets/umbels shows positively correlation with, no. of seed/umblets (0.380), test Weight (0.245), and yield (0.064). Ajowain no. of seed/umblets shows negatively correlation with, test weight (-0.312) and positively yield (0.163). Ajowain shows positively correlation test weight with, yield (0.178).

Table 3: Correlation between different observations of Ajowain crop under poplar first year

	Plant Height	No. of Branch	No. of leaves	No. of Umbels / plant	No. of Umblets/ Umbels	No. of Seed / Umblets	test Weight	Yield
Plant Height	1.000							
No. of Branch	-0.282	1.000						
No. of leaves	0.438	0.122	1.000					
No. of Umbels / plant	-0.007	-0.158	0.300	1.000				
No. of Umblets/ Umbels	-0.069	0.469	-0.121	-0.098	1.000			
No. of Seed / Umblets	0.208	0.141	-0.036	-0.524	0.380	1.000		
test Weight	-0.306	0.295	0.199	0.121	0.245	-0.312	1.000	
Yield	-0.021	-0.310	-0.281	-0.408	0.064	0.163	0.178	1.000

Correlation between different observations of Coriander crop under poplar first year

Table 4depicted the Coriander of plant height shows positively correlated with Leaves (0.205), No. of Umbels / plant (0.019), test Weight (0.334), Yield (0.287) and negatively correlated with, no. of branch (-0.458), no. of umblets/umbels (-0.015), No. of Seed / Umblets (-0.073). Coriander no. of branch shows positively correlated with no. of leaves (0.143), No. of Umbels / plant (0.284), No. of Umblets/ Umbels (0.160), test weight (0.019) and negatively correlated with, No. of Seed / Umblets (0.337), Yield (-0.200). Coriander number of leaves shows positively correlation with No. of Umbels / plant (0.197), No. of Seed / Umblets (0.027), test Weight (0.498) and negatively correlation with, no. of umblets/umbels (-0.146), Yield (-0.081). Coriander no. of umbels/plant shows negatively correlation with, no. of umblets/umbels (-0.166), No. of Seed / Umblets (-0.034),test Weight (-0.046), yield (-0.054). Coriander no. of umblets/umbel shows positively correlation test Weight (0.238), yield (0.003) and negatively correlation with No. of Seed / Umblets (-0.408). Coriander no. of seed/umblets shows positively correlation with, test weight (0.082), yield (0.214). Coriander test weight shows negatively correlation with, yield (-0.145).

Table 4: Correlation between different observations of Coriander crop under poplar first year

	Plant Height	No. of Branch	No. of leaves	No. of Umbels / plant	No. of Umblets/ Umbels	No. of Seed / Umblets	test Weight	Yield
Plant Height	1.000							
No. of Branch	-0.458	1.000						
No. of leaves	0.205	0.143	1.000					
No. of Umbels / plant	0.019	0.284	0.197	1.000				
No. of Umblets/ Umbels	-0.015	0.160	-0.146	-0.166	1.000			
No. of Seed / Umblets	-0.073	-0.337	0.027	-0.034	-0.408	1.000		
test Weight	0.334	0.019	0.498	-0.046	0.238	0.082	1.000	
Yield	0.287	-0.200	-0.081	-0.054	0.003	0.214	-0.145	1.000

Correlation between different observations of Fenugreek crop under poplar first year

Table 5 depicted the Fenugreek of plant height shows positively correlated with No. of Branch (0.185), no. of leaves (0.213), No. of pod/ Plant (0.455) and negatively correlated with, No. of seed /pod (-0.205), test Weight (-0.019), Yield (-0.014). Fenugreek no. of branch shows

positively correlated with no. of leaves (0.150), No. of seed /pod (0.183), Yield (0.400) and negatively correlated with, No. of pod/ Plant (-0.137), test Weight (-0.153). Fenugreek number of leaves shows positively correlation with No. of pod/ Plant (0.249), test Weight (0.144), Yield (0.121) and negatively correlation with, No. of seed /pod (-0.193). Fenugreek No. of pod/ Plantshows negatively correlated with, No. of seed /pod (-0.393), test Weight (-0.389), yield (-0.247). Fenugreek No. of seed /podshows positively correlation with test Weight (0.042), yield (0.293). Fenugreek test Weightshows positively correlation with, yield (0.231).

Table 5: Correlation between different observations of Fenugreek crop under poplar first year

	Plant Height	No. of Branch	No. of leaves	No. of Pod/plant	No. of Seed per pod	test Weight	yield
Plant Height	1.000						
No. of Branch	0.185	1.000					
No. of leaves	0.213	0.150	1.000				
No. of pod/ Plant	0.455	-0.137	0.249	1.000			
No. of seed /pod	-0.205	0.183	-0.193	-0.393	1.000		
Test weight	-0.019	-0.153	0.144	-0.389	0.042	1.000	
yield	-0.014	0.400	0.121	-0.247	0.293	0.231	1.000

Correlation between different observations of Mentha crop under poplar first year

Table 6 depicted the Mentha of plant height shows positively correlated with No. of Branch (0.602), no. of leaves (0.203) and negatively correlated with, Yield (-0.010). Mentha no. of branch shows positively correlated with Yield (0.203) and negatively correlated with, no. of Leaves (-0.200). Mentha no. of leaves shows positively correlated with, Yield (0.017).

Table 6: Correlation between different observations of Mentha crop under poplar first year

	Plant Height	No. of Branch	No. of leaves	yield
Plant Height	1.000			
No. of Branch	0.602	1.000		
No. of leaves	0.203	-0.200	1.000	
Yield	-0.010	0.203	0.017	1.000

Correlation between different observations of Kalonji crop under poplar first year

Table 7 depicted the Kalonji of plant height shows positively correlated with no. of leaves (0.456), No. of pod/ Plant (0.456) and negatively correlated with, No. of Branch (-0.177), No. of seed /pod (-0.310), test Weight (-0.459), Yield (-0.438). Kalonji no. of branch shows positively correlated with No. of seed /pod (0.256), test Weight (0.515) and negatively correlated with, no. of Leaves (-0.441), No. of pod/ Plant (-0.300), Yield (0.178). Kalonji number of leaves shows positively with No. of pod/ Plant (0.281) and negatively correlation with, No. of seed /pod (-0.500), test Weight (0.390), Yield (-0.113). Kalonji No. of pod/ Plantshows positively with yield (0.125) and negatively correlated with, No. of seed /pod (-0.331), test Weight (-0.412). Kalonji No. of seed /pod shows positively correlation with test Weight (0.366) and negatively correlation with, yield (0.300). Kalonji test Weightshows positively correlation with, yield (0.143).

Table 7: Correlation between different observations of Kalonji crop under poplar first year

	Plant Height	No. of Branch	No. of leaves	No. of Pod/plant	No. of Seed per Pod	Test Weight	yield
Plant Height	1.000						
No. of Branch	-0.177	1.000					
No. of leaves	0.456	-0.441	1.000				
No. of pod / plant	0.456	-0.300	0.281	1.000			
No. of seed /pod	-0.310	0.256	-0.500	-0.331	1.000		
Test weight	-0.459	0.515	-0.390	-0.412	0.366	1.000	
yield	-0.438	-0.178	-0.113	0.125	-0.300	0.143	1.000

Correlation between different observations of Chilli crop under poplar first year

Table 8 depicted the Chilli of plant height shows positively correlated with no. of leaves (0.213), test weight (0.261), yield (0.611) and negatively correlated with, no. of branch (-0.064), no. of fruit/plant (-0.003). Chilli no. of branch shows positively correlated with no. of leaves (0.437) and negatively correlated with, no. of fruit/plant (-0.094), test weight (-0.165), yield (-0.037). Chilli no. of leaves shows positively correlated with, no. of fruit/plant (0.195) and negatively correlated with test weight (-0.316), yield (-0.015). Chilli no. of fruit/plantshows negatively

correlated with test weight (-0.065) and yield (-0.041). Chilli test weightshows positively correlated with yield (0.638).

Table 8: Correlation between different observations of Chilli crop under poplar first year

	Plant Height	No. of Branch	No. of leaves	No. of fruit /plant	test Weight	yield
Plant Height	1.000					
No. of Branch	-0.064	1.000				
No. of leaves	0.213	0.437	1.000			
No. of fruit/plant	-0.003	-0.094	0.195	1.000		
Test weight	0.261	-0.165	-0.316	-0.065	1.000	
yield	0.611	-0.037	0.015	-0.041	0.638	1.000

Correlation between different observations of Cumin crop under poplar first year

Table 9 depicted the Cumin of plant height shows positively correlated with no. of branch (0.443), No. of Umbels / umbels (0.173), test Weight (0.598) and negatively correlated with, no. of leaves (-0.345), no. of umblets/plant (-0.119), No. of Seed / Umblets (-0.050), yield (-0.422). Cumin no. of branch shows positively correlated with no. of leaves (0.141), No. of Umbels / plant (0.042), No. of seed/ Umbels (0.262), test weight (0.543), yield (0.313) and negatively correlated with, No. of Umblets/umbels (-0.058). Cumin number of leaves shows positively with No. of Umbels / plant (0.201), No. of Seed / Umblets (0.370), test Weight (0.241),Yield (0.081) and negatively correlation with, no. of umblets/umbels (-0.404). Cumin no. of umbels/plant shows positively correlation with, no. of umblets/umbels (0.098), No. of Seed / Umblets (0.206),test weight (0.092), yield (0.331). Cumin no. of umblets/umbel shows positively correlation with no. of seed/umbels (0.310), test Weight (0.113) and negatively correlation with yield (-0.527). Cumin no. of seed/umblets shows positively correlation with yield (0.020) and negatively correlation with, test weight (-0.070). Cumin test weight shows negatively correlation with, yield (-0.137).

Table 9: Correlation between different observations of Cumin crop under poplar first year

	Plant Height	No. of Branch	No. of leaves	No. of umbels/plant	No. of umblets/umbels	No. seed / umbels	Test weight	Yield
Plant Height	1.000							
No. of Branch	0.443	1.000						
No. of leaves	-0.345	0.141	1.000					
No. of umbels/plant	-0.119	0.042	0.201	1.000				
No. of umblets/umbels	0.173	-0.058	-0.404	0.098	1.000			
No. seed / umbels	-0.050	0.262	0.370	0.206	0.310	1.000		
Test weight	0.598	0.543	0.241	0.092	0.113	-0.070	1.000	
Yield	-0.422	0.313	0.388	0.331	-0.527	0.020	-0.137	1.000

Conclusion

The findings of present study concludein all result thatcommon parameter positive and negativecorrelation between Plant Height, No. of Branch, No. of leaves, No. of Umbels / plant, No. of Umblets/ Umbels, No. of Seed / Umblets, test Weight,yield of Fennel, Ajowain, Coriander, Fenugreek, Mentha, Kalonji, Chilli and Cumin. In all the crop shows plant height shows positively correlated with No. of Branch, no. of leaves, No. of pod/ Plant. In case of no. of branch shows positively correlated with no. of leaves, No. of Umbels / plant, No. of seed/ Umbels, test weight and yield. In case of number of leaves shows positively with No. of Umbels / plant, No. of Seed / Umblets, test Weight and Yield. In case of no. of umblets/umbel shows positively correlation with no. of seed/umbels, test Weight.

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