RESEARCH ARTICLE

EFFECTS OF ORGANIC, INORGANIC AND BIO-FERTILIZERS ON THE GROWTH OF MAIZE UNDER SUBABUL (*LEUCAENA LEUCOCEPHALA*) BASED AGROFORESTRY SYSTEM

Mukesh Yadav[1], Rajiv Umrao[1] and Sandeep Rout*

[1]*College of Forestry, Sam Higginbottom University of Agriculture Technology & Sciences, Prayagraj, Uttar Pradesh, INDIA*
Email: sandeeprout1988@gmail.com

Received-13.03.2019, Revised-16.04.2019

Abstract: A field trail was carried out at the research farm of College of Foresrty, SHUATS, Prayagraj. The experimental site situated at an altitude of 90 M above the MSL at 25^0.57' N latitude and 81^0 51' E longitude. The experiment comprised of nine treatments replicated thrice. The maximum germination percentage (94.27%), plant height (72.10 cm) at 30DAS, 176.37 cm at 60 DAS and 183.67 cm at 90 DAS, number of cob/plant(1.22), ear length (17.90 cm), number of rows/cob (13.78), number of grains/cob (369.33), test weight (216.93), grain yield (q/ha) (38.50), stover yield (69.29) and harvest index (35.73) were recorded in T_8 (A Chroococcum+ Phosphate Solubilizing Bacteria+Vermicompost (3t/ha) maximize the maize growth and yield under subabul trees. Therefore, it may be concluded that A Chroococcum+ Phosphate Solubilizing Bacteria+Vermicompost (3t/ha), can be recommended for growing maize under subabul based agroforestry system for obtaining better growth and yield.

Keywords: Agroforestry, Bio fertilizer, Manure, Subabul

INTRODUCTION

Agroforestry is primarily defined as an approach to land use that incorporates 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 cope up with ever increasing demand for diversified products.
Agroforestry offers an economical and ecologically viable option for large scale diversification in agriculture on one hand and environmental amelioration on the other. The increasing population and rapid industrialization has increased pressure on the traditional forests for timber and other related wood products. Therefore, to save forests and meet the growing demands of wood, there is need for large scale plantations of fast growing tree species outside forests to make country self reliant in its timber requirements. Fast growing tree species with rotation of less than ten years like Poplar, Eucalypts, Leucaena, Casuarina, Willow, etc. have gained preference due to their higher productivity and acceptability in the market. On-farm timber tree plantations can also benefit from the global environmental facilities like carbon trading (Pandey, 2007 and Dogra, 2007).
Traditionally, agro-forestry 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. Furthermore, tree- based inter-cropping systems can result in more diversified economies for both short- and long-term products and provide a market for both agronomic and forest crops. Inter-cropping systems can also play a vital role in sequestering carbon below- and above-ground plant components, thereby addressing present and critical societal concerns about global climate change (Thevathasan, et.al, 2004 and Brandle, et. al, 1992).
Agroforestry practices vary according to the agro climatic zones and socio-economic status of the farmers. Considering the tree diversity, existing cropping pattern, availability of irrigation water, soil, climate, rainfall and other agro-meteorological characteristics of the area, the state is divided into nine agro-climatic zones, viz. (i) Bhabhar and Tarai Zone, (ii) Bundelkhand Zone, (iii) Central Zone, (iv) Eastern Plain Zone, (v) Mid-Western Plain Zone, (vi) North Eastern Plain Zone, (vii) South Western Semi-Arid Zone, (viii) Vindhyan Zone and (ix) Western Plain Zone (Singh, 2014**).** The Gangetic Plain at the centre is large as it covers nearly two-thirds of the state. The whole region is densely populated and immensely vital for the economy of the state. The soil in the region is mostly alluvial, which is fertile. The main crops of the region include paddy, wheat, sugarcane, grams and millets. The eastern tract of this Plain is subjected to periodical floods and droughts, while, the western and central tracts are comparatively better with a well-developed irrigation system. (3) The Vindhyan Hills and plateau in the south which majorly comprises the Bundelkhand division. Rainfall is scanty and erratic with limited or scarce water resources which force the practice of dry land farming on a large scale in the region. There are two main cropping seasons in the state, viz. Rabi

*Corresponding Author

and Kharif. The kharif cropping season is from July to October during the southwest monsoon. Paddy, maize, Jowar, Bajra, Pulses (Arhar, Black gram, and Green gram), Potato, Cotton, Groundnut and Soybean are the various crops grown in the kharif season. Rabi cropping season is from October to March, and the important Rabi crops are Wheat, Barley, Peas, Chickpea and Mustard. The state produces numerous diverse crops due to its comparative advantage of a wide range of agro-climatic conditions (Dwivedi *et. al*, 2007 and Kareemulla *et. al*, 2005).

Agroforestry seems to be a viable and economically feasible solution for the farmers to meet the challenges of food, nutrition, energy, employment and environmental security. Promotion and proper implementation of the recently launched Agroforestry Policy of India, 2014 is a big challenge for the Government of India, though agroforestry is one of the solutions to reduce the growing pressure on the forests, enhance tree cover and to fulfil the shortage of industrial timber. It is also considered as a good alternative for food security (Singh *et.al*, 2014). Although land management systems, which envisage combination of agricultural crops and trees on the same land unit, are though age old, but lacked scientific inputs (Srinidhi *et al*., 2007) literature also reveals ample vacuum regarding systematic studies on production of different agriculture crops under varied tree canopies and the interactions of both. The scanty information available reflects both positive response in some crops and inverse trend with other when raised under tree canopy. If such systems have to be recommended for adoption on large scale for sustainable production, compatibility studies among agricultural crops and tree species have to be expeditiously undertaken.

Leucaena leucocephala is a medium sized fast growing tree belongs to the family Fabaceae. It is native to Southern Mexico and Northern Central America (Hill, 1971). The specific name 'leucocephala' comes from 'leu' meaning white and 'cephala', meaning *L. Leucocephala* head, referring to the flowers. It is commonly known as White Lead tree, White Popinac, Jumbay and Wild Tamarind. In India, it is popularly known as kubabul or Subabul (Chandrasekhara, 1984). It has also been described as a "conflict tree" because it has been promoted for its forage production and naturally spreads like a weed. It grows up to 20 m height. Leaves are looking like that of tamarind having white flowers tinged with yellow, and having long flattened pods. Seeds are dark brown with hard shining seed coat. The tree has multifarious uses like firewood, timber, greens, fodder, and green manure; provide shade, controls soil erosion (Gardezi, 2004), is a legume and in the symbiosis with Rhizobia bacteria the tree is able to fix about 500 kg nitrogen per ha annually. The nitrogen fixing nodules are found on the small lateral roots near the soil surface (Azeemoddin, 1988).

Alley cropping is a type of Agroforestry system consisting of simultaneous combination of trees and/or shrubs, usually nitrogen-fixing species, banded interspersed with annual crops. Trees or shrubs are pruned regularly to use biomass as green manure and/or firewood, with the main objective of improving soil fertility and/or quality fodder. This system also promotes the use of green manure (Kang, 1993 and Khare, 2016) reported higher production and economical gains in *Leucaena leucocephala* alley cropping systems with maize grown in rotation with black oats.

Maize is one of the most important cereal crops of India not only in terms of hectares, but also in terms of its versality for adoption under wide range of agroclimatic and crop growing situations. Intercropping of cereal crops between the rows of timber, fodder and fuel tree species may provide good opportunity to diversify agroforestry and increase economic returns to the farming community due to diversify agroforestry and increase economic returns to the farming community due to fast growth and valuable timber.

Maize is called "King of cereals" because of its productivity potential compared to any other cereal crop. Being an exhaustive crop, it has very high nutrient requirement and its productivity is closely depends on nutrient management system. Under the present trend of exploitive agriculture in India, inherent soil fertility can no longer be maintained on the sustainable basis. It is said that nutrient supplying capacity of soil declines steadily under continuous and intensive cropping system. The of optimum levels of N, P, K failed to maintain yield levels probably due to increasing secondary and micronutrient deficiencies and also unfavorable alterations in the physical and chemical properties of soil. Organic matter improves water holding capacity of sandy soil and drainage in clayey soil. Organic manure provides nutrients for the soil micro-organisms, thus increases the activities of microbes in soil, which in turn help to convert unavailable plant nutrients into available form for plant growth promotion. The bio fertilizers are found positive contribution to soil fertility, resulting in an increase in crop yield without causing any environmental, water or soil pollution hazards. Nitrogen fixing and Phosphorus solubilizing bacteria play an important role in nitrogen mobilization and phosphorus solubilization for the benefit of plant growth (Umesha *et al.*, 2014).

Bio-fertilizers are the inoculations of microbial cultures which are actually multiplied artificially of certain soil microorganisms that can improve soil fertility and crop productivity. Bio-fertilizers are economical as they cost very low and are also the renewable sources through which the plant gets nutrients which supplement chemical fertilizers. Bio-fertilizers provides nutrient supply like nitrogen and phosphorous through their activities in the soil or rhizosphere and makes them available to the plants on the soil. Bio-fertilizers are now very important because they are properly maintaining the health of the soil and are reducing pollutions in the environment by cutting down the use of chemicals.

Azotobacter

These bacteria belong to the family of *Azoto bacteriaceae*, aerobic, free living, and heterotrophic in nature. They are found in neutral oralkaline soils and *A. chroococcum*are the most common occurring species in arable soils. *A.vinelandii, A.beijerinckii, A. insignis* and *A.macrocytogenes*are other reported species. *Azotobacter* rarely exceeds of 104 to 105 g^{-1} of soil due to lack of organic matter and presence of antagonistic microorganisms in soil. The population number of *Azotobacter* rarely exceeds of 104 to 105 g-1 of soil due to lack of organic matter and presence of antagonistic microorganisms in soil.

Phosphate solubilizers

These bacterial species has the ability to solubilize insoluble inorganic phosphate compounds, which are tricalcium phosphate, dicalcium phosphate, hydroxyapatite, and rock phosphate. The examples among the bacterial genera with this are *pseudomonas, Bacillus, Rhizobium.*

The information on these aspects of subabul based agroforestry system involving organic, inorganic and bio-fertilizers on the growth of maize is meager. Keeping in the view of the importance of crops a preliminary investigation was made to study growth and yield of maize under subabul based agroforestry system.

MATERIALS AND METHODS

The investigation was carried out at the nursery of College of Forestry, Sam Higginbottom University of Agriculture Technology and Sciences, Prayagraj during the period of July 2016 - October 2016. Evaluation of the compatibleness of maize under Subabul (6 years old) based agroforestry system was carried out. Prayagraj is situated at an elevation of 90 meters above the sea level; it is situated at 25.57^0N latitude and 81.51^0E longitude. Allahabad is located in the South eastern part of Uttar Pradesh and has a sub-tropical climate with extremes of summer and winter. During the summer season, the temperature reaches up to 45-48^0C, while during the winter season, especially in the month of December and January temperature drops down to as low as 1-20^0C, frost and during summer, hot scorching wind are common features. The average rainfall in this area is around 886.00 mm, during the monsoon i.e. July to September, with a few occasional light showers and drizzles are seen in the winter also (Maurya *et al.*, 2016) (Table.1). Prior to starting the experiment the selected plot remained fallow in Rabi season; organic manures were used for the experiment. The organic manures used were well decomposed Farm Yard Manures, Vermicompost, and Neem Cake as per the following treatment details- T_0- Control, T_1- 50%NP+100%K+A. Chroococcum + Phosphate Solubilizing bacteria +FYM (5t/ha), T_2- 50%NP+100%K+A. Chroococcum + Phosphate solubilizing Bacteria+Vermicompost (3t/ha), T_3- 50%NP+100%K+A. Chroococcum+ Phosphate Solubilizing Bacteria+Poultry manure (5t/ha), T_4- Rec. of NPK+VC (3t/ha), T_5- Rec. of NPK+PM (5t/ha),T_6- Rec. of NPK+FYM (5t/ha), T_7- A. Chroococcum + Phosphate Solubilizing Bacteria+FYM (5t/ha), T_8-. A Chroococcum+ Phosphate Solubilizing Bacteria+Vermicompost (3t/ha), T_9-. Chroococcum + Phosphate Solubilizing Bacteria+Poultry manure (5t/ha). Pre sowing operation like ploughing, weeding and leveling, demarcation and layout application of organic fertilizer, sowing of seeds were carried out manually (Table 2 and 3). After the sowing, timely irrigation and weeding of the field were carried out as and when required. First irrigation was done immediately after sowing of the crop while the subsequent irrigations were provided at 20 and 40 Days after sowing (DAS). Two manual weeding were provided as and when required. Various post- sowing operation, i.e. inter culture operations were carried out as and when required as per the crop. The experiment was conducted in Randomized Block Design (RBD) having five treatment combinations which were replicated thrice. Harvesting was carried during morning hour after 120 days of sowing. Visually yellowing of leaves indicates the maturity stage reached. Pre-harvest observations i.e., (at 30, 60 and 90 DAS) **-** germination%**,** plant height (cm)**,** number of cob per plants, Cob per rows, grains per cob**,** grain yield (t/ha), straw yield (t/ha), test weight (g) of seeds were recorded and Harvest index (%) calculated. The raw data obtained during the experimental observations were subjected to statistical analysis as per method by Gomez and Gomez, (1984). The significance and non-significance of the treatment effects were judged with the help of 'F' variance ratio test. Calculated 'F' value (variance ratio) was compared with the table value of 'F' at 5% level of significance.

RESULTS AND DISCUSSION

The present study was carried out to find out the efficacy of organic, inorganic and biofertilizers (Vermicompost, Poultry manure, Farmyard manure, Azotobacter and PSB) under Subabul based Agroforestry system and to find out their best combination for growth, yield and economic feasibility of Maize crops. The results of the investigation have been presented in tables, and graphically illustrated through bar-diagrams, wherever required, and discussed in the light of the findings reported by earlier researchers. Similar findings of higher germination percentage (96.67%)

also reported in case of soybean under Subabul based agro forestry system (Khare e*t al.* 2016)

Germination (%)

The data presented in table 4 revealed that the germination was significantly influenced by treatments. However, maximum germination was recorded (94.27%) with the application of A. chroococcum+Phosphate solubilizing bacteria+Vermicompost (3t/ha) (T_8).This may be due to better soil condition with application of organics and biofertilizers. The results are in alignments with the results of Umesha *et al.* (2014) and Hameeda *et al.* (2008).

Plant height (cm)

The data presented in table 5 revealed that all treatment trail in this experiment produced considerable amount of changes in plant height. These varies in plant height were recorded at 30, 60, and 90 DAS and are presented as follows.

At the primary stage of grow i.e. at 30 DAS the treatment combination of maize crops produced non-significant differences in plant height. However, maximum plant height was recorded in T_8 (72.10), followed by T_9 (68.60), which were found to be at par the minimum plant height was recorded in T_0 (48.67) in control.

At 60 DAS, the treatment combination of crop significantly differ in plant height the maximum plant height was recorded in T_8 (176.37) followed by T_9 (174.67), the minimum plant height was recorded in T_0 (128.20) in control.

At 90 the treatment combination of crop significantly differ in plant height the maximum plant height was recorded in T8 (183.67), followed by T_9 (181.67) the minimum plant height was recorded in T_0 (136.23) in control. Similar results in case of plant height significantly highest (66.86 cm) were also reported by Kumar et al (2015) in Lin seed in teak based agroforestry system. Prakash et al (2002) also reported that organic manures like FYM increases the plant height of *C. officinalis* as compared to control. These results are in conformity with the findings of Yadav *et al.* (2000) where they reported that media consisting red soil+ FYM (1:1) was the best in respect of plant height for Marigold.

Number of cob per plant

The treatment (T_8) havingA.chroococcum+Phosphate solubilizing bacteria+Vermicompost (3t/ha)resulted in the production of non- significantly higher number of cob per plant of maize (1.22), and (T_9) also having A. chroococcum+Phosphate solubilizing bacteria+Poultry manure (5t/ha) (1.22). Organic manures not only slowly release nutrients slowly but also prevent the losses of leaching (Table.6).

Ear length (cm)

The data on Ear length (cm) are presented in table 7. It is evident that the Ear length (cm) different significantly among the different treatment combination.

The Ear length were found highest in T_8 (17.90), followed by T_9 (17.33) which were found to be at par. The lowest Ear length (cm) were found in T_0 (15.00) in control**.**

Number of Rows per cob

The data on **Number of Rows/cob** are presented in table 8. It is evident that the number of Rows/cob different significantly among the different treatment combination.

The number of Rows/cob were found highest in T_8 (13.78), followed by T_9 (13.55) which were found to be at par. The lowest number of Rows/cob were found in T_0 (10.78) in control**.**

Number of grains per cob

The data on number of grains/cob are presented in table 9. It is evident that the number of grains/cob different significantly among the different treatment combination.

The number of grains/cob were found highest in T_8 (369.33), followed by T_9 (358.00) which were found to be at par. The lowest No. of grains/cob were found in T_0 (234.00) in control**.**

Test weight (g)

The test weight of seed is presented in table 10 which differed significant the different treatment combination. Higher seed was recorded in T_8 (216.93) followed by T_9 (215.91) and minimum seed was recorded in T_0 (190.17) of course the maximum yield per plant was pertaining to cultivar T_8 never the less. The maximum test weight was recorded in T_8. This might be due to bold seeded characteristic of the cultivar T_8.

Grain yield (q/ha)

The data on Grain yield are presented in table 11. It is clear from the table significant variation were noticed among the variation in aspect of Grain yield. The treatment combination (T_8) gave the highest yield of (38.50) per plant followed by T_4 (37.50). The minimum Grain yield was recorded in T_0 (12.13). This indicates that crop grown with incorporate with organic manures is benefited from it. It not only source of nutrients but also provides overall growth of crop and crop yield (Khare, *et al.* 2016, Thongney, *et al.* 2018)

Straw Yield (q/ha)

The data on Straw yield (q/ha) are presented in table 12. It is clear from the table significant variation were noticed among the variation in aspect of Straw yield. The treatment combination (T_8) gave the highest yield of (38.50) per plant followed by T_4 (37.50). The minimum Straw yield was recorded in T_0 (12.13). This may be due to the effect of different nutrient management practice which made significant variations at different stages of crop till harvest, these findings are corroborated with the findings of Gayan *et al*. (2004).

Harvest Index (%)

The data on Harvest Index (%) are presented in table 13. It is clear from the table significant variation were noticed among the variation in aspect of

Harvest Index. The treatment combination (T_8) gave the Harvest Index of (35.73) per plant followed by T_4 (35.21). The minimum Harvest Index was recorded in T_0 (21.77). Similr results were reported by Kaushik and Singh, (2001) in case of Wheat. Apart from nutrients light is a major limiting factors for the crop growth and yeild under tree species corroborative results were also reported by Tripathi et al. (2001).

Table 1. Meteorological data collected during study period (July 2016 to October 2016)

SMW	Dates	Rainfall (mm)	Temperature (^{0}C)		Relative humidity (%)	
			Max.	Min.	I	II
27	2nd -8th July	21.94	38.42	27.25	82.85	52.71
28	9th -15th July	0.91	37.22	27.54	82.42	44.28
29	16th-22nd July	4	34.54	27.30	86.71	48.71
30	23rd -29th July	0.8	35.8	27.45	82.14	47.71
31	30th July- 5th Aug	17.05	35.71	26.57	85.28	48.00
32	6th -12th Aug	4.34	33.82	27.14	88.28	55.42
33	13th -19th Aug	25.94	33.14	27.00	91.71	56.71
34	20th -26th Aug	6.2	34.48	27.11	88.71	55.57
35	27th Aug -02nd Sept	6.94	35.82	27.28	90.57	53.42
36	3rd -9th Sept	0.65	35.14	27.20	87.85	53.85
37	10th -16th Sept	4.91	35.25	27.28	89.42	54.28
38	17th -23rd Sept	1.14	33.28	26.87	89.14	62.57
39	24th -30th Sept	8.08	30.25	26.22	89.42	66.28
40	1st -2th Oct	6.37	34.65	26.68	87.42	53.85

Source: Agro-Meteorological Unit, College of Forestry, SHUATS, Prayagraj (UP)

Table 2. Mechanical analysis of soil (Bouyoucos hydrometer methods, 1927)

Ingredients	Percentage (%)
Sand	58%
Silt	24%
Clay	18%
Texture Name	Sandy loam

Table 3.

Particulars	Analyzed Value	Methods employed
Organic carbon (%)	0.45	Walkley and Black(1927)
Available nitrogen (Kgha^{-1})	221	Alkaline permanganate method of (Subbiah and Asija 1956)
Available phosphorus (Kgha^{-1})	22.5	Olsen’s colorimeter methods (1954)
Available potassium (Kgha^{-1})	358	Flame Photometric method (Toth and Prince 1949)
Soil pH 1:2 soil water suspension (w/v)	7.8	Digital pH (Jackson 1954)
Ec (dSm-1)1:2 water suspension (w/v)	0.48	Digital conductivity meter (Jackson 1954)

Table 4. Effects of organic, inorganicand biofertilizers on Germination (%) of Maize (*Zea mays* L.) under Subabul (*Leucaena leucocephala*) based agroforestry system.

Treatment no.	**Treatment**		**Germination %**
T_0	Control		89.33
T_1	50%NP+100%K+A. Chroococcum + Phosphate Solubilizing bacteria + FYM (5t/ha)		93.00
T_2	50%NP+100%K+A. Chroococcum+Phosphate solubilizing bacteria+Vermicompost (3t/ha)		93.57
T_3	50%NP+100%K+A. chroococcum+Phosphate solubilizing bacteria+Poultry manure (5t/ha)		93.87
T_4	Rec. of NPK+VC (3t/ha)		92.97
T_5	Rec. of NPK+PM (5t/ha)		93.40
T_6	Rec. of NPK+FYM (5t/ha)		93.57
T_7	A. chroococcum+Phosphate solubilizing bacteria+FYM (5t/ha)		93.43
T_8	A. chroococcum+Phosphate solubilizing bacteria+Vermicompost (3t/ha)		94.27
T_9	A. chroococcum+Phosphate solubilizing bacteria+Poultry manure (5t/ha)		93.77
	Mean		**93.12**
	Range	Min	89.33
		Max	94.27
	F – Test		**S**
	SE ±d		**1.13**
	CD (5%)		**2.38**

Table 5. Effects of organic, inorganic and biofertilizers on Plant Height (cm) of Maize (*Zea mays*L.) under Subabul (*Leucaena leucocephala*) based agroforestry system at different intervals after sowing

Treatment no.	**Treatment**		**Plant Height**		
			30 DAS	**60DAS**	**90 DAS**
T_0	Control		48.67	128.20	136.23
T_1	50%NP+100%K+A. Chroococcum + Phosphate Solubilizing bacteria + FYM (5t/ha)		59.97	156.03	160.33
T_2	50%NP+100%K+A. Chroococcum + Phosphate solubilizing Bacteria+Vermicompost (3t/ha)		60.70	166.80	170.87
T_3	50%NP+100%K+A. chroococcum+Phosphatesolubilizing bacteria+Poultry manure (5t/ha)		59.40	160.93	165.80
T_4	Rec. of NPK+VC (3t/ha)		59.43	151.67	154.87
T_5	Rec. of NPK+PM (5t/ha)		58.60	152.70	152.73
T_6	Rec. of NPK+FYM (5t/ha)		54.83	152.57	155.97
T_7	A. chroococcum+Phosphate solubilizing Bacteria+FYM (5t/ha)		67.83	173.80	180.07
T_8	A. chroococcum+Phosphate solubilizing bacteria+Vermicompost (3t/ha)		72.10	176.37	183.67
T_9	A. chroococcum+Phosphate solubilizing bacteria+Poultry manure (5t/ha)		68.60	174.67	181.67
	Mean		**61.01**	**159.37**	**164.22**
	Range	Min	48.67	128.20	136.23
		Max	72.10	176.37	183.67
	F - Test		**S**	**S**	**S**
	SE ±d		**3.58**	**4.75**	**2.68**
	CD (5%)		**7.53**	**9.99**	**5.64**

Table 6. Effects of organic, inorganic and biofertilizers on Number of Cob / Plant of Maize (*Zea mays*L.) under Subabul (*Leucaena leucocephala*) based agroforestry system.

Treatment no.	**Treatment**	**Number of cob/plant**
$\mathbf{T_0}$	Control	1.00

T_1	50%NP+100%K+A. Chroococcum + Phosphate Solubilizing bacteria + FYM (5t/ha)		1.00
T_2	50%NP+100%K+A. Chroococcum+Phosphate solubilizing bacteria+Vermicompost (3t/ha)		1.00
T_3	50%NP+100%K+A. chroococcum+Phosphate solubilizing bacteria+Poultry manure (5t/ha)		1.00
T_4	Rec. of NPK+VC (3t/ha)		1.00
T_5	Rec. of NPK+PM (5t/ha)		1.00
T_6	Rec. of NPK+FYM (5t/ha)		1.00
T_7	A. chroococcum+Phosphate solubilizing bacteria+FYM (5t/ha)		1.00
T_8	A. chroococcum+Phosphate solubilizing bacteria+Vermicompost (3t/ha)		1.22
T_9	A. chroococcum+Phosphate solubilizing bacteria+Poultry manure (5t/ha)		1.22
	Mean		**1.04**
	Range	Min	1.00
		Max	1.22
	F – Test		**NS**
	SE ±d		**0.14**
	CD (5%)		**0.30**

Table 7. Effects of organic, inorganic and biofertilizers on Ear Length (cm) of Maize (*Zea mays* L.) under Subabul (*Leucaena leucocephala*) based agroforestry system.

Treatment no.	**Treatment**		**Ear length (cm)**
T_0	Control		10.49
T_1	50%NP+100% K+A. Chroococcum + Phosphate Solubilizing bacteria + FYM (5t/ha)		15.00
T_2	50%NP+100%K+A. Chroococcum+Phosphate solubilizing bacteria+Vermicompost (3t/ha)		15.90
T_3	50%NP+100%K+A. chroococcum+Phosphate solubilizing bacteria+Poultry manure (5t/ha)		15.67
T_4	Rec. of NPK+VC (3t/ha)		15.10
T_5	Rec. of NPK+PM (5t/ha)		14.20
T_6	Rec. of NPK+FYM (5t/ha)		14.30
T_7	A. chroococcum+Phosphate solubilizing bacteria+FYM (5t/ha)		16.73
T_8	A. chroococcum+Phosphate solubilizing bacteria+Vermicompost (3t/ha)		17.90
T_9	A. chroococcum+Phosphate solubilizing bacteria+Poultry manure (5t/ha)		17.33
	Mean		**15.26**
	Range	**Min**	10.49
		Max	17.90
	F – Test		**S**
	SE ±d		**0.81**
	CD (5%)		**1.70**

Table 8. Effects of organic, inorganic and biofertilizers on Number of Rows/Cob of Maize (*Zea mays* L.) under Subabul (*Leucaena leucocephala*) based agroforestry system.

Treatment no.	**Treatment**	**Number of Rows/cob**
T_0	Control	10.78
T_1	50%NP+100%K+A. Chroococcum + Phosphate Solubilizing Bacteria + FYM (5t/ha)	13.11
T_2	50%NP+100%K+A. Chroococcum+ Phosphate Solubilizing Bacteria+Vermicompost (3t/ha)	13.33
T_3	50%NP+100%K+A. Chroococcum+ Phosphate Solubilizing bacteria+Poultry manure (5t/ha)	13.11
T_4	Rec. of NPK+VC (3t/ha)	12.67

T_5	Rec. of NPK+PM (5t/ha)		12.67
T_6	Rec. of NPK+FYM (5t/ha)		12.22
T_7	A. Chroococcum + Phosphate Solubilizing Bacteria+FYM (5t/ha)		13.33
T_8	A. Chroococcum + Phosphate Solubilizing Bacteria+Vermicompost (3t/ha)		13.78
T_9	A. Chroococcum+PhosphateSolubilizing Bacteria + Poultry Manure (5t/ha)		13.55
	Mean		**12.85**
	Range	**Min**	10.78
		Max	13.78
	F – Test		**S**
	SE ±d		**0.52**
	CD (5%)		**1.09**

Table 9. Effects of organic, inorganic and biofertilizers on Number of Grains / Cobof Maize (*Zea mays* L.) under Subabul (*Leucaena leucocephala*) based agroforestry system.

Treatment no.	**Treatment**		**Number of grains/cob**
T_0	Control		234.00
T_1	50%NP+100%K+A. Chroococcum + Phosphate Solubilizing Bacteria + FYM (5t/ha)		300.67
T_2	50%NP+100%K+A. Chroococcum+ Phosphate Solubilizing Bacteria+Vermicompost (3t/ha)		314.67
T_3	50%NP+100%K+A. Chroococcum+ Phosphate Solubilizing bacteria+Poultry manure (5t/ha)		312.00
T_4	Rec. of NPK+VC (3t/ha)		301.33
T_5	Rec. of NPK+PM (5t/ha)		298.33
T_6	Rec. of NPK+FYM (5t/ha)		300.00
T_7	A. Chroococcum + Phosphate Solubilizing Bacteria+FYM (5t/ha)		350.00
T_8	A. Chroococcum + Phosphate Solubilizing Bacteria+Vermicompost (3t/ha)		369.33
T_9	A. Chroococcum+PhosphateSolubilizing Bacteria + Poultry Manure (5t/ha)		358.00
	Mean		**313.83**
	Range	**Min**	234.00
		Max	369.33
	F – Test		**S**
	SE ±d		**12.84**
	CD (5%)		**26.98**

Table 10. Effects of organic, inorganic and biofertilizers on Test Weight (gm.) of Maize (*Zea mays* L.) under Subabul (*Leucaena leucocephala*) based agroforestry system.

Treatment no.	**Treatment**	**Test weight (gm.)**
T_0	Control	190.17
T_1	50%NP+100%K+A. Chroococcum + Phosphate Solubilizing Bacteria + FYM (5t/ha)	205.70
T_2	50%NP+100%K+A. Chroococcum+ Phosphate Solubilizing Bacteria+Vermicompost (3t/ha)	209.93
T_3	50%NP+100%K+A. Chroococcum+ Phosphate Solubilizing bacteria+Poultry manure (5t/ha)	207.70
T_4	Rec. of NPK+VC (3t/ha)	203.63
T_5	Rec. of NPK+PM (5t/ha)	201.33
T_6	Rec. of NPK+FYM (5t/ha)	198.50
T_7	A. Chroococcum + Phosphate Solubilizing Bacteria+FYM (5t/ha)	213.03
T_8	A. Chroococcum + Phosphate Solubilizing Bacteria+Vermicompost (3t/ha)	216.93

T_9	A. Chroococcum+PhosphateSolubilizing Bacteria + Poultry Manure (5t/ha)		215.91
	Mean		**206.28**
	Range	**Min**	190.17
		Max	216.93
	F – Test		**S**
	SE ±d		**3.08**
	CD (5%)		**6.49**

Table 11. Effects of organic, inorganic and biofertilizers on Grain yield(q/ha)of Maize (*Zea mays* L.) under Subabul (*Leucaena leucocephala*) based agroforestry system.

Treatment no.	**Treatment**		**Grain yield (q/ha)**
T_0	Control		12.13
T_1	50%NP+100%K+A. Chroococcum + Phosphate Solubilizing Bacteria + FYM (5t/ha)		31.40
T_2	50%NP+100%K+A. Chroococcum+ Phosphate Solubilizing Bacteria+Vermicompost (3t/ha)		32.67
T_3	50%NP+100%K+A. Chroococcum+ Phosphate Solubilizing bacteria+Poultry manure (5t/ha)		32.27
T_4	Rec. of NPK+VC (3t/ha)		31.23
T_5	Rec. of NPK+PM (5t/ha)		28.97
T_6	Rec. of NPK+FYM (5t/ha)		27.83
T_7	A. Chroococcum + Phosphate Solubilizing Bacteria+FYM (5t/ha)		35.83
T_8	A. Chroococcum + Phosphate Solubilizing Bacteria+Vermicompost (3t/ha)		38.50
T_9	A. Chroococcum+PhosphateSolubilizing Bacteria + Poultry Manure (5t/ha)		37.10
	Mean		**30.79**
	Range	**Min**	12.13
		Max	38.50
	F - Test		**S**
	SE ±d		**1.74**
	CD (5%)		**3.65**

Table 12. Effects of organic, inorganic and biofertilizers on Stover yield(q/ha)of Maize (*Zea mays* L.) under Subabul (*Leucaena leucocephala*) based agroforestry system.

Treatment no.	**Treatment**		**Straw yield (q/ha)**
T_0	Control		44.03
T_1	50%NP+100%K+A. Chroococcum + Phosphate Solubilizing Bacteria + FYM (5t/ha)		63.73
T_2	50%NP+100%K+A. Chroococcum+ Phosphate Solubilizing Bacteria+Vermicompost (3t/ha)		63.76
T_3	50%NP+100%K+A. Chroococcum+ Phosphate Solubilizing bacteria+Poultry manure (5t/ha)		60.08
T_4	Rec. of NPK+VC (3t/ha)		63.58
T_5	Rec. of NPK+PM (5t/ha)		64.11
T_6	Rec. of NPK+FYM (5t/ha)		62.35
T_7	A. Chroococcum + Phosphate Solubilizing Bacteria+FYM (5t/ha)		64.69
T_8	A. Chroococcum + Phosphate Solubilizing Bacteria+Vermicompost (3t/ha)		69.29
T_9	A. Chroococcum+PhosphateSolubilizing Bacteria + Poultry Manure (5t/ha)		68.94
	Mean		**62.46**
	Range	**Min**	44.03
		Max	69.29

	F – Test	**S**
	SE ±d	**5.14**
	CD (5%)	**10.80**

Table 13. Effects of organic, inorganic and biofertilizers on Harvest Index of Maize (*Zea mays* L.) under Subabul (*Leucaena leucocephala*) based agroforestry system.

Treatment no.	Treatment		Harvest Index (%)
T_0	Control		21.77
T_1	50%NP+100%K+A. Chroococcum + Phosphate Solubilizing Bacteria + FYM (5t/ha)		33.07
T_2	50%NP+100%K+A. Chroococcum+ Phosphate Solubilizing Bacteria+Vermicompost (3t/ha)		34.07
T_3	50%NP+100%K+A. Chroococcum+ Phosphate Solubilizing bacteria+Poultry manure (5t/ha)		35.10
T_4	Rec. of NPK+VC (3t/ha)		32.90
T_5	Rec. of NPK+PM (5t/ha)		31.17
T_6	Rec. of NPK+FYM (5t/ha)		30.97
T_7	A. Chroococcum + Phosphate Solubilizing Bacteria+FYM (5t/ha)		35.78
T_8	A. Chroococcum + Phosphate Solubilizing Bacteria+Vermicompost (3t/ha)		35.73
T_9	A. Chroococcum+PhosphateSolubilizing Bacteria + Poultry Manure (5t/ha)		35.21
	Mean		**32.57**
	Range	**Min**	21.77
		Max	35.78
	F – Test		**S**
	SE ±d		**1.65**
	CD (5%)		**3.47**

CONCLUSION

The different growth and yield parameters of maize Viz. Maximum germination % germination percentage (94.27%), plant height (72.10 cm) at 30DAS, 176.37 cm at 60 DAS and 183.67 cm at 90 DAS, number of cob/plant(1.22), ear length (17.90 cm), number of rows/cob (13.78), number of grains/cob (369.33), test weight (216.93), grain yield (q/ha) (38.50), stover yield (69.29) and harvest index (35.73) were recorded in T_8 (A Chroococcum+ Phosphate Solubilizing Bacteria+Vermicompost (3t/ha) maximize the maize growth and yield under Subabul based agroforestry system. So it may be concluded that T_8 can be recommended to the grower for the cultivation of Maize under Subabul based agroforestry system during the Kharif Season in Prayagraj Condition.

REFERENCES

Azeemoddin, G., Rao, Jagan Mohan. and Rao, S. Thirumala (1988). *J Food Sci Technol*. 25: 158.

Brandle, J.R., Wardle, T.D. and Bratton, G.F. (1992). Opportunities to increase tree plantings in shelterbelts and the potential impacts on carbon storage and conservation. In: Sampson RN, Hairs D (eds) Forests and global change. American Forests, Washington DC. 1(9):157–175.

Dogra, A.S. (2007). Contribution of trees outside forests toward wood production and environmental amelioration. Indian Journal of Ecology. 38:1-5

Dwivedi, P.R., Karemulla, K., Singh, R., Rizvi, R.H. and Chauhan, J. (2007). Socio-Economic Analysis of Agroforestry Systems in Western Uttar Pradesh. Indian Res. *J Ext. Edu*. 7(2- 3).

Gardezi, A.K., Barcelo-Quintal, I.D., Cetina-Alcala, V.M., Bussy, A.L. and Borja Salin, M.A. (2004). Studies of phytoremediation by Leucaena leucocephala in association with arbuscular endomycorrhiza and Rhizobium in soil polluted by Cu. Proceedings of 8th World conference on Systemics, Cybernetics and Informatics, Orlando Florida, USA. 33-39 pp.

Gayen, S.K., Gupta, D.K. and Sarawgi, S.K. (2004). Effect of decomposed cow dung and urine mixture with or without inorganic fertilizer, soil conditioning and PSB on the root volume and nodules performance of soybean [*Glycine max* (L.) Merrill]. *Annals of Agricultural Research*.25(4): 541-545.

Gomez, K.A. and Gomez, A.A. (1984). Statistical procedures for Agricultural Res. 2nd edn. John Wiley and Sons, New York, 680 pp.

Hameeda, B., Harini,G., Rupela,O.P., Wani S.P. and Reddy, Gopala .(2008).Growth promotion of maize by phosphate solubilizing bacteria isolated from composts and macrofauna. *Microbiological Research*.163:234-242.

Hill, G.D. (1971). Leucaena leucocephala for pastures in Tropics. Herbae Abstracts 4: 111-19.

Jackson, M.L. (1973). Soil Chemical Analysis, Prentice Hall of India Pvt Ltd., New Delhi.

Kang, B.T. (1993). "Changes in Soil Chemical Properties and Crop Performance with Continuous Cropping on an Entisol in the Humid Tropics". In. Mulongoy and Mercks R. (Eds). Soil Organic Matter Dynamics And Sustainability Of Tropical Agriculture. John Wiley and Sons. 297-305 Pp.

Kareemulla, K., Rizvi, R.H., Kumar, K., Dwivedi, R.P., Singh, R. (2005).Poplar Agroforestry Systems in Western Uttar Pradesh: A Socio – economic analysis Forests. *Trees and Livelihoods.* 15(4):375-382.

Kaushik, N. and Singh, J. (2001). Performance of pearl millet-wheat in popular based agri-silvicultural system in sandy soils of southern Haryana. *Indian J. of Agro forestry*. 31(1): 51-54.

Khare, N., Kumar, D. and Rout, S. (2016). Effect of organic manure on growth and yield attributes of Soybean under *Leucaena leucocephala* based Agroforestry system. *Journal of Applied and Natural Science.* 8(4): 2219-2223.

Kumar, H., Umarao, R. and Tripathi, M.K. (2015). Varietal performance of Linseed planted at different pacing under Teak based agro forestry system. *J. Int. Acad. Res. Multidiscip*, 2(8): 261-268.

Maurya, S.K., Nath, S., Patra, S.S. and Rout, S. (2016). Effect of different dates of sowing on growth and yield of pearl millet (*Pennisetum glaucum* L.) varieties under Allahabad condition. *International Journal of Science and Nature*. 7(1): 62-69.

Pandey, D.N. (2007). Multifunctional agroforestry in India. *Current Science*. 92(4):455-463

Prakash, A., Sindhu, S.S., Sharma, S.K. and Prakash, A. (2002). Effect of phosphorus and FYM on yield parameters of marigold in chloride dominated saline soil. *Haryana Journal of Horticulture Sciences*. 31(3-4): 207 -210.

Rao, Chandrasekhara T., Lakshminarayana, G., Prasad, N.B.L., Rao, Sagan Mohan S., Azeemoddin, G., Atchynta Ramayya, D., Thirumala Rao, S.D.(1984). *J Am Oil Chem Soc*. 61: 1472-3.

Singh, P.(2014). Population and agro climatic zones in India: an analytical analysis. Proc. Soc. Behav. Sci.120: 268–278

Srinidhi, H.V., Chauhan, S.K. and Sharma, S.C. (2007) SWOT analysis of Indian agroforestry. *Ind. J. Agrof*. 9:1-11.

Subbiah, B. V. and Asija, G. L. (1956). A rapid procedure for estimation of available nitrogen in soils. *Current Science*. 25: 259-260.

Thevathasan, N.V., Gordon, A.M. (2004). Ecology of tree intercropping systems in the north temperate region: Experiences from southern Ontario, Canada. *Agroforest Syst.* 61:257–268.

Thevathasan, N.V., Gordon, A.M., Simpson J.A., Reynolds P.E., Price G. and Zhang P.(2004). Biophysical and ecological interactions in a temperate tree-based intercropping system. *J Crop Improvement*. 12 (1–2): 339–363.

Thongney, P.L., Khare, N., Rout, S. and Debbarma, R. (2018). Effect of different level of vermi-compost and FYM organic manures on quality parameters of Cucumber intercropped with Citrus based agroforestry system. International Journal of recent scientific research.9 (12A):29847-29850.

Tripathi, M.K., Saini, B.C. and Chaturvedi, S. (2006). Growth and yield of intercropped wheat under Salix-Dalbergia agro forestry system. Annals of Bio. of Agric. and Tech., Pantnagar, Uttrakhand, India. 22(2):189.

Umesha, S., Srikantaiah, M., Prasanna, K.S., Sreeramulu, K.R., Divya, M. and Lakshmipathi, R.N. (2014). Comparative effect of organics and biofertilizers on growth and yield of maize (*Zea mays* L.). *Curr. Agr. Res. J*. 2: 55-62.

Yadav, P.K., Singh, S. Dhindwal, A.S. and Yadav, M.K. (2000). Effect of N and FYM application on floral characters and yield of African marigold. Haryana Journal of Horticulture sciences.29 (1-2): 69-71.