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Characteristics of Soil under Greengram-Plum based Agroforestry System in Kashmir Valley, India

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A B S T R A C T

The present investigation was carried out at experimental Farm of the Division of Fruit Science, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Shalimar, Srinagar during the year 2011 and 2012 to study the physical and chemical properties of soil. The experiment was laid out in a randomized block design with three replications comprising seven treatments and sole cropping of green gram and plum as controls. The tree spacing was 4 x 4 m and spacing of 40 x 10 cm for green gram intercrop was maintained. Seeds were sown in the month of July, 2011. The different doses of organic manures and fertilizers and green gram intercrop had a positive role in making the nutrients more available. Among the different doses of organic manures and fertilizers, 80 per cent of recommended doses of NPK + FYM + Dal weed + Biofertilizer (rhizobium) were found to be most efficient. The use of organic manures and fertilizers in combination has been found to be more efficient than organic manures alone. Different doses of organic manures and fertilizers are found to be having influence on available nitrogen, available potassium and available phosphorus.

Introduction

Agroforestry, the relatively new name for the old practice of growing trees and crops in interacting combination, is now recognized as an approach to increasing farm productivity in low - external - input, resource - limited situations. Many, if not most, agroforestry systems have developed over long periods of time in response to interactions between agro-ecological conditions, plant diversity, and farmer resources and needs. This new concept which came to be known as agroforestry today is even more relevant in the context of growing human and livestock population especially in developing countries like India. According to Asian survey of Agrarian reforms and rural development sponsored by FAO, 1970 per cent of Indian farmers have marginal land holdings which are living much below the poverty line and the ultimate solution of their economic upliftment lies in the establishment of agro/wood, agro/fruit tree based industry at village level. Though, agroforestry appears to be the lone logical solution for sustainable livelihood. It is an integrated land use approach, including cultivation of woody perennials, fruit trees in

association with annual crops and holds immense potential to ensure stability and sustainability in production and to provide ecological and economic security as compared to conventional system of mono-cropping. However, to prove its credibility this farming system requires appropriate selection of tree crop-combinations so as to use available resource most efficiently (Huxley, 1996). In an agroforestry system competitive interaction develops between trees and crops for the limiting resources, aboveground for light and below ground for soil, water and nutrients. Asymmetry in resource utilization in agroforestry is due to difference in establishment timing of trees and crops (Bhatt *et al.*, 2003).

Fruit producing species like apple, plum, etc. are the best studied example of intensive fruit tree based agroforestry (Fernandes and Nair, 1986). Plum, an important temperate stone fruit belongs to family Rosaceae and sub-family Prunoideae. It ranks next to peaches in economic importance. Being a delicious juicy fruit, it is used both as fresh and in preserved form. Besides having medicinal properties, it is a fairly good source of citric acid, sugars and vitamin A (Westwood, 1993). In Jammu and Kashmir, the area under plum is 4397 hectares with an annual production of 8603 metric tonnes (Anonymous, 2011). Pulses occupy an indispensable position in the dietary habit of vast majority in the Indian subcontinent. Besides, being nutritionally fulfilling, these contribute to the restoration of the soil fertility. Pulses are mostly of short duration, fit better in rotation and can be grown as main, inter, catch, green manure or cover crop that keeps the soil medium productive and sustainable. In India, pulses are grown on an area of 4.02 million hectares, with production and productivity at 6.43 million tones and 593 kg ha^{-1}, respectively (Anonymous, 2012). In Jammu and Kashmir state, pulses cover an area of 29.99 thousand hectares, with production and productivity at 138.89 thousand quintals and 4.63 quintals per hectare, respectively (Anonymous, 2010). The experiment was planned to find out the effect of different doses of organic manures and fertilizers on physico-chemical properties of greengram and plum under plum-based agroforestry system and to compare the properties before and after the experiment.

Materials and Methods

The experimental orchard, the study area, is situated at a latitude of 32^{o} N and an altitude of 1650 meters above sea level. The study area lies in temperate zone of Jammu and Kashmir State, which received an annual rainfall of 23.7 mm. The average maximum monthly temperature ranged from 18 to 35 ^{o}C and average minimum monthly temperature varied from 7.4 to 21.5 ^{o}C.

Soil characteristics

Before laying out the experiment, random soil samples were collected from the depth of 0-20 cm from different spots and the composite sample was prepared which was analysed for various soil characteristics in order to get beforehand information about the physico-chemical properties of the soil. The methods employed and results obtained for important physico-chemical characteristics (initial) of the soil of experimental area have been summarized in table 1.

At the completion of the experiment, the samples from each plot were again drawn and analyzed for various characteristics by the standard methods.

Soil moisture (%)

The soil moisture content was determined gravimetrically. Before laying out the experiment, random soil samples were collected up to the depth of 20 cm, by using auger and the composite sample was

prepared. The composite sample was dried at 105^{o}C till constant weight and the soil moisture content was calculated as under:

$$\text{Soil moisture (\%)} = \frac{\text{Fresh weight} - \text{Dry weight}}{\text{Fresh weight}} \times 100$$

At the completion of the experiment, the samples from each plot were again drawn and soil moisture (%) content was determined.

Methodology

The green-gram crop was studied with respect to the soil physico-chemical properties of soil in response to organic manures and fertilizers in an agri-horticulture system. The experimental details followed and methods adopted are given below:

Agroforestry system	:	Agri-horticulture
Structural components	:	The system was based on the following components
Agricultural crop	:	Greengram or Mung bean (*Vigna radiata*) (SM-1)
Tree component	:	Plum (*Prunus salicina*) cv. Santa Rosa
Tree spacing	:	4 x 4 m
Age of the tree component	:	6 years
Spacing for greengram intercrop	:	40 x 10 cm
Number of treatments	:	9
Replications	:	03
Total Number of plots	:	27
Design	:	RBD (Randomized Block Design)

Treatments

Symbol	Treatment		
T_1	Control (only Plum)	:	No Manure and Fertilizer applied
T_2	Control (only Greengram)	:	No Manure and Fertilizer applied
T_3	FYM	:	2 t/ha
T_4	Dalweed Manure	:	2 t/ha
T_5	Biofertiliser (Rhizobium)	:	5 g/kg seed
T_6	Vermicompost	:	1 t/ha
T_7	Biofertiliser + Vermicompost (50%)	:	5 g/kg seed + 500 kg/ha

Statistical analysis

All the data obtained were subjected to the statistical analysis as per procedure given by Gomez and Gomez (1984) using R-Software.

Results and Discussion

The present investigation entitled "Physico-chemical properties of soil under Greengram-Plum based Agroforestry System in Kashmir valley" was carried out at the experimental farm of the Division of Fruit Science, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Shalimar, Srinagar during the year 2011 and 2012. The data recorded on different soil characters were statistically analyzed and significance of results was verified.

Soil pH

The data pertaining to the effect of different levels of organic manures and fertilizers on soil pH are given in table 2. It indicates that the treatments significantly influenced pH.

The highest value (6.89) of pH was observed under treatment T_8 supplied with 80 per cent of recommended doses of NPK + FYM + dalweed + biofertilizer (Rhizobium), followed by T_9 (6.85) in which plants were supplied with 60 per cent of recommended doses of NPK + FYM + dalweed + biofertilizer (Rhizobium) and the least value (6.41) was found in T_1 i.e. control (only plum without organic manure and fertilizer application).

Electrical conductivity

A perusal of data enumerated in table 2 reveals that all the treatments had a significant influence on electric conductivity (EC). In the depth 0-20 cm, 0.33 dSm^{-1} was the highest value of EC under treatment T_8 i.e., plots supplied with 80 per cent of recommended doses of NPK + FYM + dalweed + biofertilizer (Rhizobium), followed by T_9 (0.32 dSm^{-1}) in which plots were supplied with 60 per cent of recommended doses of NPK + FYM + dalweed + biofertilizer (Rhizobium) and the least value (0.26 dSm^{-1}) was found in T_1 i.e., control (only plum without organic manure and fertilizer application).

Soil moisture

A perusal of data enumerated in table 2 reveals that all the treatments had a significant influence on soil moisture. The highest value (6.40%) of soil moisture was observed under T_8 supplied with 80 per cent of recommended doses of NPK + FYM + dalweed + biofertilizer (Rhizobium) followed by T_6 (6.20 %) in which plants were supplied with vermicompost and the least (5.60%) was found in T_2 i.e., control (sole cropping of greengram without organic manure and fertilizer application).

Available nitrogen

Application of different doses of organic manures and fertilizers significantly influenced the available N content of soil (Table 2). In the surface soil (0-20 cm), the maximum available N (346.82 kg ha^{-1}) was recorded for the treatment T_8 where plants were supplied with 80 per cent of recommended doses of NPK + FYM + dalweed + biofertilizer (Rhizobium) followed by treatment T_9 (343.13 kg ha^{-1}) where plants were supplied with 60 per cent of recommended doses of NPK + FYM + dalweed + biofertilizer (Rhizobium). In the same depth the least value (332.00) of available N, was observed in T_1 i.e. control (only plum without organic manure and fertilizer application).

Available phosphorus

It is evident from the data in table 2 that different doses of organic manures and fertilizers significantly influenced the available P content of soil. In the surface soil (0-20 cm), the maximum available P (23.15 kg ha^{-1}) was recorded for the treatment T_8, where plants were supplied with 80 per cent of recommended doses of NPK + FYM + dalweed + biofertilizer (Rhizobium), followed by T_9 (21.00 kg ha^{-1}). In the same depth the least value for available P (17.11 kg ha^{-1}) was observed in treatment T_2 i.e., control (only greengram without organic manure and fertilizer application.

Available potassium

A perusal of data enumerated in table 2 reveal that there was significant effect of different treatments on available K content of soil. In the surface soil (0-20 cm), the maximum available K (150.82 kg ha-^{1}) was recorded for the treatment T_8 where plants were supplied with 80 per cent of recommended doses of NPK + FYM + dalweed + biofertilizer (Rhizobium), followed by T_9 (147.32 kg ha^{-1}) (136.40 kg ha^{-1}) was observed in T_1 i.e. control (only plum without organic manure and fertilizer application).

The present study was undertaken to investigate the effect of different doses of organic manures and fertilizers on phsico-chemical properties of soil under greengram plum-based agroforestry system. The findings of the study are discussed in light of the available literature.

The application of different doses of organic manures and fertilizers found to have influence on EC (dSm^{-1}), soil moisture, available nitrogen, available phosphorus, available potassium and soil pH (Table 2).

The present study revealed that as the amount of organic manure is increased, there was a decline in the values of pH. The slight decline in the soil pH under organic manure treatment could be attributed to the production of organic acids formed during decomposition of organic matter. The results are in accordance with the findings of Srikanth *et al*., (2000) and Jayabhaskaran *et al*., (2001), who also reported a decline in the soil pH with application of poultry manure and vermi-compost.

The data pertaining to electrical conductivity revealed that application of organic manures and fertilizers significantly influenced electrical conductivity during the study. Soils which had received organic manures and fertilizers recorded more increase in EC over initial value which is obviously due to addition of salts in the soil. These results are in line with the findings of Vijay *et al*., (2007).

The data pertaining to soil moisture reveal that application of organic manures and fertilizers significantly influenced soil moisture during the study. The increase in soil moisture (%) can be attributed to the improvement in soil structure and water holding capacity of the soil due to addition of organic manures. These results are in line with the findings of Gupta *et al*., (1977), Khaleel *et al*., (1981), Metzger and Yaron (1987). Bijalwan (2010) reported that soil moisture was higher in agri-horticulture compared to sole agriculture (tree less or control). The highest moisture status of soil can also be attributed to reduction in water evaporation, therefore, conserving the available water in soil (Agele, 2000).

Table.1 Physico-chemical properties of soil before planting (0-20 cm)

S. No.	Parameters	Test value	Method employed
1.	Soil pH	6.90	Glass electrode method (Jackson, 1973)
2.	Electric conductivity (dSm^{-1}) at $25^{o}C$ (1:2 soil-water suspension)	0.28	Solu bridge conductivity meter (Piper, 1966)
3.	Soil moisture (%)	5.31	Gravimetric method
4.	Available nitrogen (kg ha^{-1})	328.6	Alkaline permagnate method (Subbiah and Asija, 1956)
5.	Available phosphorus (kg ha^{-1})	16.8	Olsen method (Olsen *et al*., 1954)
6.	Available potassium (kg ha^{-1})	130.8	Flame Photometer method (Jackson, 1973)

Table.2 Effect of organic manure and fertilizers on available nutrients and physical properties at the time harvesting of greengram

Treatment		Available nutrient content (kg ha^{-1})			Soil pH	EC (dSm^{-1})	Soil moisture (%)
		Nitrogen	Phosphorus	Potassium			
T_1	Control (only Plum)	332.00	17.96	136.40	6.41	0.26	5.65
T_2	Control (only Greengram)	333.02	17.11	137.00	6.46	0.27	5.60
T_3	FYM	336.07	18.91	139.33	6.60	0.30	6.00
T_4	Dalweed Manure	334.06	18.11	138.00	6.49	0.29	5.90
T_5	Biofertiliser (Rhizobium)	335.00	18.00	140.00	6.68	0.28	5.70
T_6	Vermicompost	339.51	20.05	143.61	6.78	0.30	6.20
T_7	Biofertiliser + Vermicompost (50%)	337.93	19.08	142.81	6.74	0.31	5.85
T_8	80% of recommended doses of NPK + FYM + Dalweed + Biofertiliser (Rhizobium)	346.82	23.15	150.82	6.89	0.33	6.40
T_9	60% of recommended doses of NPK + FYM + Dalweed + Biofertiliser (Rhizobium)	343.13	21.00	147.32	6.85	0.32	6.10
	SEm±	**0.70**	**0.11**	**0.15**	**0.01**	**0.01**	**0.01**
	CD (p≤0.05)	**2.13**	**0.33**	**0.47**	**0.03**	**0.02**	**0.04**

Data pertaining to available N, P and K revealed that different doses of organic manures and fertilizers significantly influenced the amount of available N, P and K in surface soil. Addition of organic manures with lower C:N ratio (less than 20:1) increases the microbial activity, thereby, accelerating the rate of mineralization. This might have lead to greater release of N from native organic sources, ultimately, resulting in higher N content in soils. Raina and Goswami (1988) have also reported that the addition of organic material accelerates the decomposition of native soil organic matter (a positive priming effect) thus, leading to higher mineralization and release of nutrient elements. Other workers Sreenivas *et al.*, (2000), Marimuthu *et al*., (2001) and Singh *et al*., (2002) have also reported that the inclusion of organic amendments and inorganic fertilizers at variable rates increased the soil N, P and K content. Prakash *et al*., (2002) in their study on comparative efficacy of organic manures and inorganic fertilizers in relation to nutrient availability, reported higher availability of all major nutrient elements in treatments supplemented with organic nutrient sources compared to manures and fertilizers alone.

In conclusion, the results obtained from the present investigation indicated that the green gram plants thrive well under plum based agroforestry system and can be cultivated successfully as intercrop with fruit trees. The use of organic manures and chemical fertilizers in combination has been found to be more efficient than organic manures alone. Different doses of organic manures and fertilizers are found to be having influence on available nitrogen, available potassium, and available phosphorus.

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