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Research Article

Comparative Study on Khar Mulching and Forest Litter Mulching: Soil Nutrient Dynamics in Ginger Cultivation

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Abstract

A study conducted to assess the fertility status under Khar(*Pragmites karka*) and forest litter mulching practices on ginger cultivation. Ginger field with mulching of Khar and ginger field with mulching of forest litter was identified as two strata to collect soil sample. Thirty soil samples collected from each mulching practices. Simple random sampling procedure was followed to collect soil sample within the strata. Soil fertility parameters such as soil pH, Soil organic carbon, Nitrogen, Phosphorus, Potassium were analyzed for different mulching system. Mulching material significantly effect on Soil pH, Soil organic carbon and soil nitrogen. Soil acidity was found lower with forest litter mulch (5.53) but it was found higher for Khar mulch (5.78). Soil organic carbon was found higher in ginger field with Khar mulch (2.31%) and found lower with forest litter mulch (1.97%). Soil nitrogen level was found higher in ginger field with Khar mulch (0.20%) and found lower with forest litter mulch (0.17%). Soil available phosphorus and Potassium were not found significantly different in both type of mulching system. The result obtained from the study indicates that ginger field with Khar mulch result soil with higher soil organic carbon and Nitrogen. Mulching decision can also be made after testing the soil of respective ginger growing field. Appropriate liming could be done so that it could reduce the soil acidity problems.

Keywords: Forest Litter; Khar; Mulching; Soil organic carbon.

Introduction

Ginger (*Zingiber officinale*) is an important rhizomatous spice, medicine, cash as well as industrial crop (Ernst & Pittler, 2000; Nwaogu, 2014). Ginger require warm and shady field. It is grown from 300m to 1600m height. The suitable temperature range for growing ginger is 20-30ºC but it can resist 35 ºC (Poudel & Timilsina, 2073; Sengupta *et al*., 2009). Farmers follow traditional to improved method for growing ginger. The research site has maximum temperature of 32.2 ºC, minimum temperature of 10 ºC. In summer RH is 90% and in winter it ranges from 50-70%.

Average annual rainfall is 1208mm (Adhikari, 2072). Ginger require 20-30 Mt/ha FYM and 75-50-50 NPK per ha (Poudel & Timilsina, 2073). Farmer of this area do not use inorganic fertilizer, they use organic fertilizer. Most of the farmer use mulching practices. Animal manure is valuable source of nutrients. In addition to the nutritional effect of manure, it effect on improvement of soil organic matter, soil structure and soil microorganisms. It may contain other growth promoting substances like natural hormones and vitamins (Heintzman *et al*., 2009; Jordán *et al*., 2011). Soil organic matter is a key component of soil ecosystem and variation in its abundance and nature has profound effect on many processes that occur in the system. The amount of SOM present in soil is the result of input of organic materials and their breakdown in soil. Reduction in soil organic matter lead to loss of structure and erosion in many soils (Spain *et al*., 1983). It has been observed in upland soil, there is a declination of organic matter content from 9 to 32.56% (Alam *et al*., 2001; Govender *et al*., 2009). Long- term field plots were setup in 1989 to study the effects of mulching on soil physical properties of a silt loam soil in central Ohio. The results demonstrated that mulch rates significantly increased available water capacity by 18–35%, total porosity by 35–46% and soil moisture retention at low suctions from 29 to 70%. The study was able to determine optimum mulch rates of 4 $Mgha^{-1}$for increased porosity and 8 $Mgha^{-1}$ for enhanced available water capacity, moisture retention and aggregate stability (Mulumba & Lal, 2008). A field study was conducted to evaluate the effect of mulch on soil physical properties and N, P, K concentration in maize shoots under two types of tillage systems. Deep and conventional tillage were used along with three levels of wheat straw as mulch i.e., control, 7 and 14 Mt ha^{-1}. Mulch increased soil organic matter (1.32 g kg^{-1}) and soil moisture contents (17%), but decreased bulk density (1.35 Mtm^{-3}) and soil strength (464 kPa) compared to control. Tillage and mulch significantly affected the N and P concentration in maize shoots, while its effect on K concentration was appreciable. It is concluded that wheat straw as mulch with deep tillage improves soil physical health and crop quality (Sinkevičienė, 2009; Pervaiz *et al*., 2009). A field study conducted at Darjeeling, and West Bengal for two consecutive years to study the effect of mulching on growth and yield of ginger (*Zingiber officinale* Rose). The bed of ginger was covered with four different mulching materials viz. wheat straw, grasses and dry leaves (5.0 tons per hectare) and black polyethylene sheet (2.0 quintal per hectare) immediately after planting of seed rhizomes, along with a control plot. Among the different mulching materials, dry leaves showed greatest height (78.05 cm), number of pseudo stem per clump (4.26), leaves per clump (62.65) and highest yield (52.17 tha^{-1}) Sengupta *et al*., 2009). By knowing the status of soil fertility of land, farmer can adopt better soil nutrient management practices. Mulching material change decisions can be made by studying the effect brought out by mulching material in soil fertility. This study focuses on selection of suitable mulching material so that soil nutrient management can be done from management practices in field. There are two types of mulching system one is Khar (*Pragmites karka*) mulch and another is forest litter mulch. Both of this effects on soil physical and chemical properties of soil. After selection of suitable mulching material soil physical and chemical properties will enhance so that production of ginger could improve to some extent. This study will aid in sustainable soil management practices and might helpful in reclamation of soil.

Materials and Methods

Sample and Sampling Techniques

Soil sample was selected from the farm land within the ginger block area under Prime Minister Agriculture Modernization Project. Firstly, a pilot survey was done to identify the farm land under ginger cultivation where different management practice for mulching was followed. There are almost 210 ginger growers among them, 60 farmers were selected by stratified random sampling procedure. Two strata were made, one is a field with Khar mulch and another is field with forest litter mulch. Simple random sampling procedure was followed to collect sample within the strata(Li, 2019).

Sampling Design

Soil sampling was done using Stratified random sampling. Sampling location was assigned to predefined strata (field with Khar mulch and forest litter mulch). Simple random sampling procedure were followed to take sample within the strata (Wakimoto, 1971). Among 60 sample, 30 sample were collected from field with Khar (*Pragmites karka*) mulching that represent the one strata and 30 sample were taken from field with forest litter mulching that represent the another strata. Forest litter mulch includes fallen and dried leaf of Chilaune *(Schima wallichii*),Mahuwa *(Madhuca longifolia*),katus ***(****Castanopis tribu-loides*), Cheuri(*Aesandra bu-tyraceae)*.

Soil Sample Collection and Analysis

Soil samples were collected from 20cm depth in different mulching system. Five sub samples were collected in "M" shape from each plot within a same mulching system. These subsamples were then collected in a plastic and standard procedure was followed for obtaining 0.5 kg of composite sample. A total of 60 composite soil samples were collected from 300 soil sampling spots. The collected soil samples were labeled, brought to Regional Soil testing laboratory, Jhumka, Sunsari and were air dried in shade.

Laboratory Analysis

The collected soil sample from different mulching system were analyzed for soil pH, soil organic matter, total

nitrogen, available phosphorus and potassium content of the soil (Roy, 2008). Soil organic matter was analyzed to know the carbon content in a soil. Other nutrient such as nitrogen, phosphorus, potassium was studied to know the nutrient content of the soil in different types of mulching system.

Statistical Analysis

Data related to soil organic matter and nitrogen were rated according to standard rating of Soil Science Division, Khumaltar, Lalitpur. Data related to phosphorus and potassium was recorded based on Wardlab laboratories rating. Data entry was done with Microsoft excel 2013. Data were subjected for two independent sample t-tests. Comparison between treatment means was done using descriptive statistics at 95% confidence interval. Correlation analysis was done for the necessary parameter. Analysis of variance in a data and their comparative study with Bar-Graph was performed with Statistical tool for Agricultural Research (STAR) Version: 2.0.1. Correlation among different parameter was studied with Statistical tool for Agricultural Research (STAR) Version: 2.0.1.

Result and Discussion

The variation of soil fertility and organic matter content of different types of mulching systems are presented in Table 1.

Soil pH

The results indicate that the effect of different types of mulching system on soil pH was significant with (Pr (>|t|) value 0.0016 at (P<0.05). The higher value of pH was found in ginger field with forest litter mulch (5.78) with the standard deviation 0.36 and standard error of mean 0.07. While the lower value of pH was found in a ginger field with Khar mulch (5.53) with the standard deviation 0.22 and standard error of mean 0.04 (Fig. 1).

Soil Organic Carbon

The results indicate that the effect of different types of mulching system on soil organic carbon was found significant with (Pr (>|t|) value 0.0285 at (P<0.05). The higher value of soil organic carbon was found in ginger field with Khar mulch (2.31%) with the standard deviation 0.52 and standard error of mean 0.09. While the lower value of soil organic carbon was found in a ginger field with forest litter mulch (1.97%) with the standard deviation 0.65 and standard error of mean 0.12.

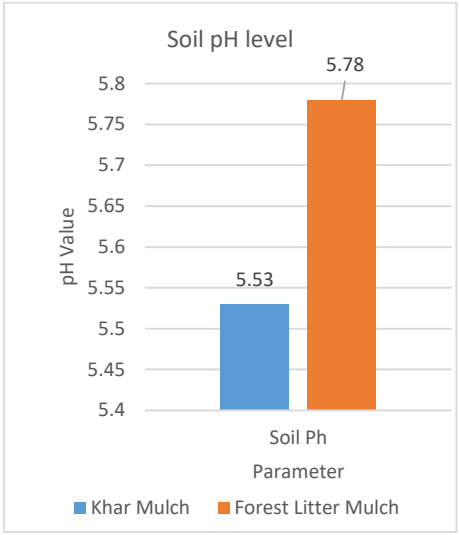

Fig. 1: Descriptive statistics on soil pH level in different types of mulching system

Six *et al*. (1998) showed in a 30-year-long Swedish field trial that biannual additions of various organic carbon residues (straw, sawdust, green manure, and FYM) had positive effects on soil Carbon levels. The highest accumulations occurred with sawdust plus N and manure amendments. It was suggested that the quality of the amendments was related to these trends as lignin contents were high for sawdust and FYM (30%) and low for straw (15%). This is in accordance with a study by Chauhan *et al*.(2014) at the Waite Permanent Rotation Trial, showing that residues high in lignin and with high C/N ratios were more resistant to decomposition than low lignin residues (Krull *et al*., 2016). We have Khar mulch with high lignin content than forest litter mulch so that organic carbon content was higher for Khar mulch soil.

Table 1: Result Summary

Parameter	Variable	No. of sample	Mean	SD of Mean	SE of Mean	Pr(>|t|)
Soil pH	Khar	30	5.53	0.22	0.04	0.0016**
	forest litter	30	5.78	0.36	0.07	
Soil Organic Carbon (%)	Khar	30	2.31	0.52	0.09	0.0285*
	forest litter	30	1.97	0.65	0.12	
Nitrogen (%)	*Khar*	30	0.20	0.04	0.01	0.0298*
	forest litter	30	0.17	0.06	0.01	
Phosphorus (mg/kg)	Khar	30	6.79	3.29	0.60	0.2145^{ns}
	forest litter	30	8.46	6.50	1.19	
Potash (mg/kg)	Khar	30	193.85	35.66	7.69	0.4260^{ns}
	forest litter	30	185.78	42.09	6.51	

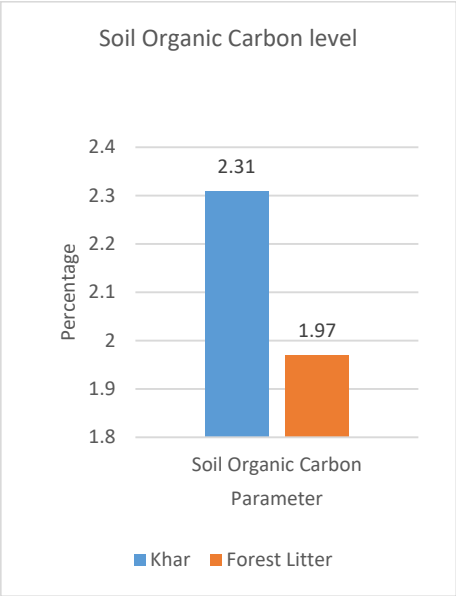

Fig. 2: Descriptive statistics on soil organic carbon level in different types of mulching system

Soil Nitrogen

The results shown in Fig. 3 indicate that the effect of different types of mulching system on soil nitrogen level was found significant with (Pr (>|t|) value 0.0298 at (P<0.05). The higher value of soil nitrogen level was found in ginger field with Khar mulch (0.20%) with the standard deviation 0.04 and standard error of mean 0.01. While the lower value of soil nitrogen level was found in a ginger field with forest litter mulch (0.17%) with the standard deviation 0.06 and standard error of mean 0.01.

These finding are also supported by a research such as organic mulches are composed of plant materials they add small amount of nutrients to the soil through the decomposition. These amounts have little effect on the nutrient level in soil and should not be considered a substitute for fertilizers. If quickly decaying organic mulches such as fresh leaves, wood chips and straw are used a considerable amount of nitrogen is taken from the soil by the microorganisms decomposing the organic matter. This reduces the nitrogen reserves in the root zone of the growing plant. If additions of nitrogenous fertilizer are not made regular, a nitrogen deficiency may result (Tolasa *et al.*, 2014).

Soil Available Phosphorus

The results indicate that the effect of different types of mulching system on soil available phosphorus content was found non-significant with (Pr (>|t|) value 0.2145 ^{ns} at (P<0.05). The higher value of soil available phosphorus content was found in ginger field with forest litter mulch (8.46 mg/kg) with the standard deviation 3.29 and standard error of mean 0.60. While the lower value of soil phosphorus content was found in a ginger field with Khar mulch (6.79 mg/kg) with the standard deviation 3.29 and standard error of mean 0.60 (Fig. 4).

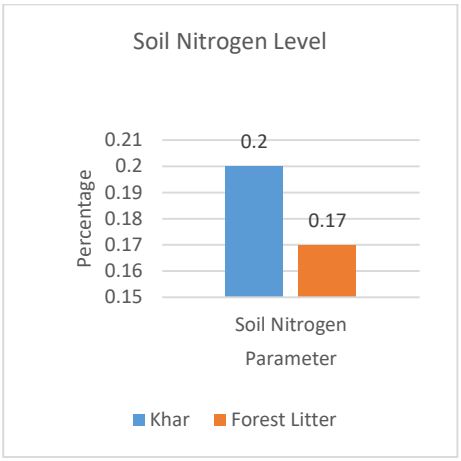

Fig. 3: Descriptive statistics on soil nitrogen level in different types of mulching system

These finding were also supported by Sinkevičienė (2009). It reveals on Grass mulch mostly influence on available phosphorus. In 2007 the content of available phosphorus of soil in non- mulched plots was higher than in plots mulched with straw, sawdust and grass.

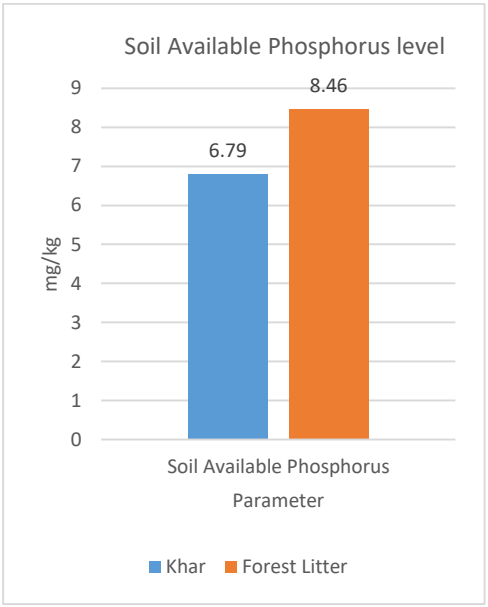

Fig. 4: Descriptive statistics on soil available phosphorus level in different types of mulching system

Soil Potassium Level

The Fig. 5 indicates that the effect of different types of mulching system on soil potassium content was found non-significant with (Pr (>|t|) value 0.4260 ^{ns} at (P<0.05). The higher value of soil potassium content was found in Khar mulch (193.85 mg/kg) with the standard deviation 35.66 and standard error of mean 7.69. While the lower value of soil phosphorus content was found in forest litter mulch

(185.78 mg/kg) with the standard deviation 42.09 and standard error of mean 6.51.

Soil potassium level was found higher for Khar mulch. The positive effect of grass mulch on available potassium in the soil was estimated. Different treatment such as without mulching, chopped wheat straw mulch, peat mulch, sawdust mulch and grass mulch were applied. Other examined mulches, straw, peat and sawdust, had no significant influence on available potassium in the soil (Sinkevičienė, 2009).

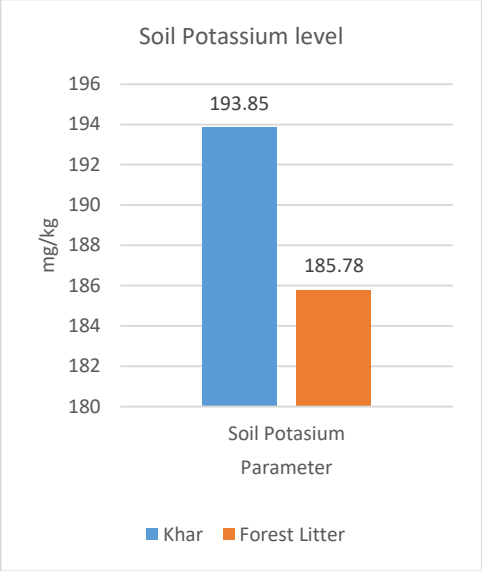

Fig. 5: Descriptive statistics on soil potassium level in different types of mulching system

Author's Contribution

All authors contributed equally in all stages from designing of the research work to the finalization of the manuscript.

Conflict of Interest

The authors declare that there is no conflict of interest with present publication.

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