

Studying of cropping system management towards improved soil fertility in the mid hills of eastern Nepal

Abstract

A research trial was conducted in the ARS, Pakhribas to study the effect of legume nodulation on yield and productivity of maize in the year 2014/2015 and 2015/2016. Maize was grown without tilling in pea harvested plots and with tilling in potato harvested plots. There were eight different treatments and maize was grown without fertilizer application in sequence with potato and pea. The highest yield of potato was observed in a treatment with application of 13.5t per ha FYM + 50:50:25 Kg N:P:K per ha. In contrast the highest yield of pea was recorded with application of 9 t FYM per ha. Moreover in maize the cob weight and biomass was the highest in the year 2014/2015 with application of 13.5t per ha FYM + 50:50:25 Kg N:P:K per ha in potato grown plot. Similarly in maize the highest biomass was observed with the application of 9 t FYM per ha pea grown plots.

Keywords: cropping system, desertification, land degradation, pakhribas, sustainable agriculture

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Introduction

Land quality degradation is a major challenge of farming community in Nepal.¹ Nepal is turning into a cold desert by desertification of more than 10,000 ha of land in Dolpa and Mustang.¹ There are different causes of land quality degradation i.e. physical, chemical and biological.² For instance shifting cultivation, deforestation, steep farming, excessive use of chemical fertilizers, excessive dependency on forest resources, overgrazing, high cropping intensity etc caused heavy loss of soil fertility.² In the top soil terrace there is loss of 87 ton/ha/yr soil.¹ This signifies a tremendous amount of soil loss every year. This is why different land management practices are followed in Nepal to preserve essential nutrient elements.¹

The world is threatened by global climate change severely and climate change that has a particularly strong effect on developing countries such as Nepal. Projection of crop yield loss with different climatic variables till 2030 is very futile. So many adaptation measures need to be followed to fetch the global demand for food.³ The many different ways to recover food requirements are shifting planting dates, switching crop varieties, prioritization of research demands on fertilizer, seed, breed, irrigation etc are necessary. In case of Nepal the impact of climate change is very serious where adaptive capacity is low and agriculture is highly dependent on climatic factors.⁴ Here in this research focus has been paid on incorporating leguminous plant on maize based cropping system to ameliorate soil fertility in comparison to potato production.

Nepal is agricultural country with over 66% of the people are directly engaged in agriculture.⁵ The nature of farming is not commercial but it is subsistent in nature and mostly integrated with livestock.⁵ However only 20% of the land is suitable for the farming, there are farming practices recorded even in the sloppy terrain.¹ Which not only deteriorate soil quality but also threaten the livelihood from soil erosion and landslide. Mostly the agricultural practices are suitable only for the Terai region but there are farming practices even ongoing with mountainous region with terracing and contouring. This

kind of human induced activities caused soil fertility degradation in overall.²

So, suitable integration strategy of crop species with different ecological requirement is necessary.⁶ Introduction of crop species in a new area with innovative technology of farming is necessary in bio-engineering.⁶ Cropping system in Nepal varies from an area to area. Potato/pea to maize crop rotation in maize based cropping system is common in the eastern midhill of Nepal. Crop rotation study for maize cultivation alternatively with Pea and Potato is proposed in this study. Potato is a highly commercial crop using high dose of chemical fertilizer whereas pea is low fertility requiring crop and has an ameliorative effect on soil fertility. Maize is another exhaustive crop in rotation requiring high energy for its growth and development. And an effect of maize plant growth and development grown alternatively with potato and pea rotation could be interesting. Thus cultivation practices of potato and pea rotated alternatively with maize production is taken into account.

Mostly maize is sown after preparing soil with good tilth either with local plough or mould board plough. Very rare practice has been seen cultivating maize without tilling the soil. However zero tillage and minimum tillage are only being practiced in the research station, the details of the impact of tillage on crop yield need to explore. Here an attempt has been made towards emphasizing conservation agriculture (CA) for the maize cultivation under pea harvested treatments. The focus of this research is to take advantage of the nitrogen fixing ability of the leguminous plant for instance pea and to conserve soil microbes with minimum disturbance to the soil strata. This is how maize is sown with minimum tillage for example dibbling under pea fertilized plots and the maize is sown conventionally in the potato fertilized plot. An attempt has been made in comparing yield of maize grown under potato fertilized plots with conventional tillage and pea fertilized plots with CA. The major objective of this research is to see the growth performance and yield of maize rotated alternatively with Pea and Potato respectively in eastern mid hill of Nepal.

Materials and methods

The research was conducted at ARS, Pakhribas in the year 2014/15 and 2015/16. Field layout was carried out into 3×3m² plot. There were eight treatments replicated three times. Local ‘Kalo’ variety of potato was planted in a spacing of 60×60cm², similarly ‘Sikkim Local’ variety of pea was planted in a spacing of 60×30cm². The eight different treatments were (a) Potato with no manures and fertilizers (control) (b) Potato with 27 ton per ha FYM (c) Potato with 13.5 ton per ha FYM plus 50:50:25Kg N:P:K per ha (d) Potato with 100:100:50 Kg N:P:K per ha (e) Pea with no fertilizers (control) (f) Pea with 9 ton FYM per ha (g) Pea with 4.5 ton FYM per ha plus 20:40:20 Kg N:P:K per ha (h) Pea with 40:80:40kg N:P:K per ha. Two crops studied were Potato and Pea grown in winter season. And each crop was rotated sequentially with maize in the spring/summer season. The performance of maize was observed under both crops with tilled and untilled soil respectively.

All the FYM was applied in the beginning of the cultivation practices. Similarly phosphorus and potassium was applied before sowing of potato and pea. Nitrogen was applied in the split doses. Half of the nitrogen was applied as basal dose and other half is applied after 35 days of sowing. Data on plant height, biomass, tubers per plant, tuber yield was recorded for the potato. Similarly data on fresh biomass, and pod fresh weight, number of pod per plant and number of seed per pod were recorded for the pea. Maize was planted after harvesting of pea and potato. Maize was planted in the potato planted plots with digging but maize was planted in the pea planted plots without digging only dibbling. Cultivation of maize was carried out only on remnant dose of fertilizer without any addition of fertilization. Data on cob weight and biomass was recorded for the both types of cultivation practices. The performance of the maize was studied under both crops in rotation. Whereas maize was grown in potato grown plots with hand hoeing and in pea grown plots with minimum tillage

Result and discussion

Leaf fresh weight and tuber yield of potato grown in different treatments in the year 2014/2015 and 2015/2016 has shown in the Figure 1. It has been seen that leaf fresh weight is higher in all the treatments in the year 2015/2016 whereas tuber yield is higher in all

the treatment in the year 2014/2015. It has been seen that vegetative growth of potato is favored in the year 2015/2016. But the process of tuberization is favored in the year 2014/2015. Comparing all the treatment the highest leaf fresh weight is observed in the treatment with application of 100:100:50 N:P:K per ha. Similar result is observed in case of tuber yield too. The highest recorded yield of potato tuber is 8.01 t/ha. On the other hand the lowest leaf fresh weight and tuber yield was observed in a treatment with no application of compost and inorganic fertilizers. Thus it is generally recommended to grow potato with 100:100:50Kg N:P:K application in the eastern mid hill of Nepal.

Similarly biomass and pod fresh weight of pea grown under different treatments in the year 2014/2015 and 2015/2016 is shown in the Figure 2. The highest biomass and pod fresh weight was observed under pea grown plots with application of 4.5t/ha FYM+20:40:20Kg N:P:K per ha in the year 2014/2015. Also application of 9t/ha FYM produced highest biomass and pod fresh weight in both cropping season. In both year of experiment conducted the application of 40:80:40Kg N:P:K per ha has poor performance than mix application of 4.5 t/ha FYM + 20:40:20 Kg N:P:K per ha. So mixture of organic and inorganic fertilizers such as 4.5t/ha FYM+20:40:20Kg N:P:K per ha performed very well up.

In the Figure 3 both biomass and cob weight (t/ha) of maize grown under potato cultivated plots without conservation agriculture is shown. Both biomass and cob weight were higher in the year 2014/2015 than in the year 2015/2016. It is due to infestation of plant maize stem borer and poor rainfall during growing season in the year 2015/2016. Moreover the cob weight (t/ha) is found to be higher in the year 2014/2015. The highest biomass is 9.43 t/ha under application of 100:100:50Kg N:P:K per ha in potato harvested plots in the year 2014/2015.

Here in the Figure 4 biomass and cob weight of maize in pea harvested plots with conservation agriculture during the year 2014/2015 to 2015/2016 is shown. Both biomass and the cob weight were higher in the year 2014/2015 than in the year 2015/2016. It is due to many extraneous factors. Some of them are poor rainfall and infestation with maize stem borer. However the highest yield was observed in the treatment with pea harvested plots under application of 4.5 t/ha FYM + 20:40:20Kg N:P:K per ha.

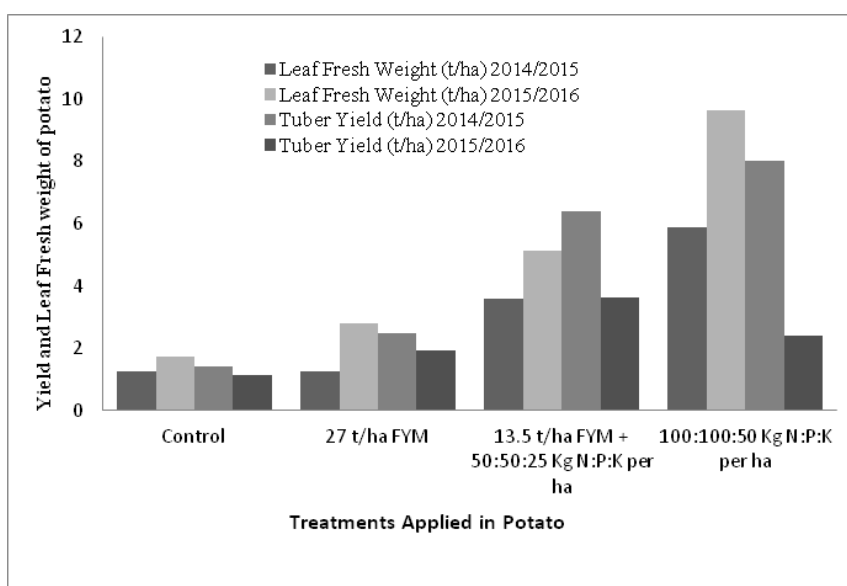


Figure 1 Leaf fresh weight and tuber yield of potato under different nutrient application.

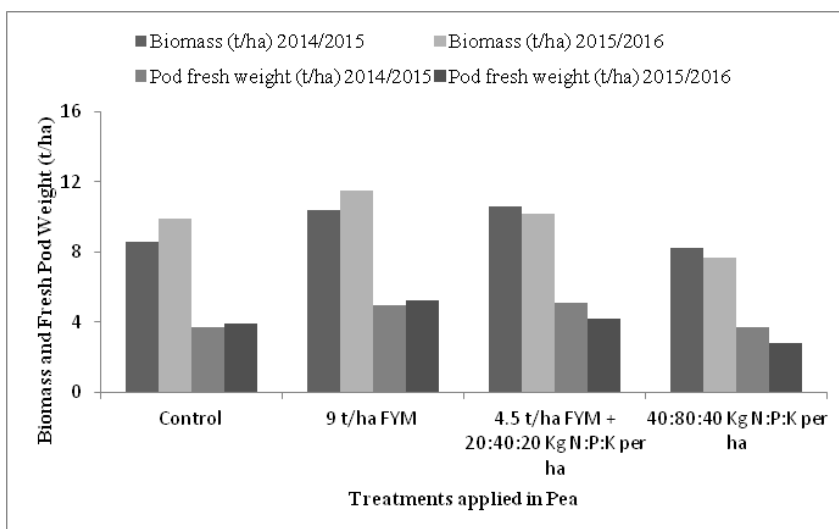


Figure 2 Biomass and fresh pod weight of pea under application of different nutrients.

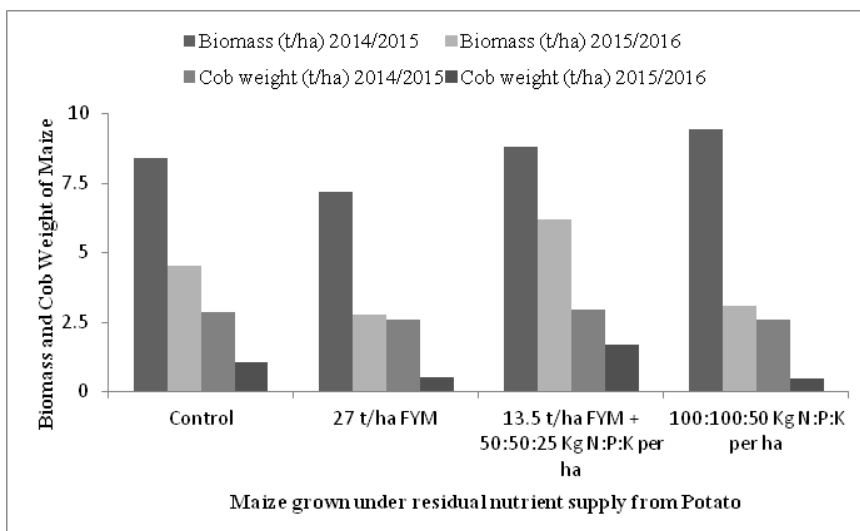


Figure 3 Biomass and cob weight of maize grown under residual nutrient supply from potato.

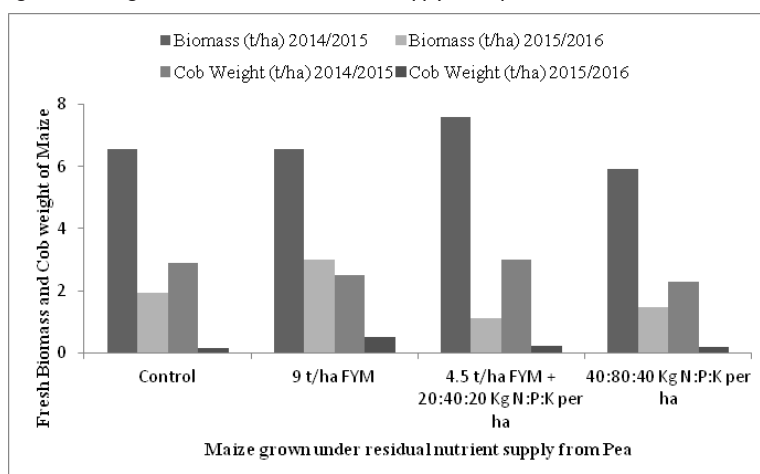


Figure 4 Biomass and cob weight of maize grown under residual nutrient supply from pea.

The result of maize grown under pea harvested plots without conservation agriculture, to the pea harvested plots with conservation agriculture was shown in the Figure 4. The maize grown under pea harvested plots without conservation agriculture is better than with conservation. Shortly maize grown under tilled soil is better than without tilling the soil. Moreover impact of legume nodulation under soil fertility amelioration under maize based cropping system is negligible. This is because that this type of study needs to be done for a longer period of time to see the response of legume nodulation on soil fertility amelioration.

Conclusion

Following conclusions were drawn from the study.

- a. The highest yield of potato was observed in a treatment with application of 100:100:50 Kg N:P:K per ha. In contrast the highest yield of pea was recorded with application of 9 t FYM per ha. Organic nutrient amendment accelerates nodulation in pea.
- b. Moreover maize grown sequentially with potato was better than pea.
- c. Cob weight and biomass was the highest in the year 2014/2015 and 2015/2016 with application of 13.5t per ha FYM+50:50:25Kg N:P:K per ha. While in case of pea grown plots the highest cob weight was observed with the application of 9 t FYM per ha.
- d. Thus it is recommended that immediate response of residual amount of chemical fertilizer improved the yield of the maize after potato. But for a long run an amendment of leguminous source of fertilizer and organic fertilizer is crucial for the growth and development of maize crop.
- e. Even more maize production under tilled soil was found better than maize production under no tilled condition. In addition soil was sampled for lab analysis to analyze nutrient content.

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Conflicts of interest

The author declares that there is in conflicts of interest.

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