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# Legume Crop Residue Management on Productivity of Succeeding Maize - An Overview

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**A B S T R A C T**

Maize is considered as important cereal crop which occupies third position after rice and wheat. Maize is considered as heavy feeder of nutrients and requires continuous and assured supply of nutrients throughout its growth period. Now-a-days, maize is grown under intensive agricultural conditions with more of chemical fertilisers although organic fertilizers are minimally used. The increased change in prices of fertilisers, deterioration of soil health and environmental concerns, are necessitating the use of organic manures which is gaining momentum. In this concern, incorporation of crop residues helps in enhancing soil fertility particularly of legumes. The update for the research undertaken on influence of legume incorporation on growth and productivity of maize is provided in this overview.

## Introduction

Maize is known as queen of cereals and is grown throughout the year mainly due to photo-thermo-sensitive character. Intensive cultivation along with the depletion of natural resources, continuous increase in costs of inputs and food prices along with climatic variability is limiting factor for enhanced food production.

Hence, use of organic manures is now gaining momentum, but incorporation of organic manures requires bulk quantities which may not be much affordable by small and marginal farmers. In this context, crop residues of previous grown legumes can be used to overcome the problem of soil fertility.

Incorporation of crop residues alters the soil environment, which in turn influences microbial population and activity in soil and subsequent nutrient transformations (Yadvinder-Singh *et al.*, 2005). Proper management and utilisation of crop residues can be important factor in achieving the increased food production and enhanced soil fertility. Legumes are well known to fix up atmospheric nitrogen to enhance soil fertility while leaving some nitrogen in their residues which can be used by subsequent crops.

After harvest of economic parts, the legumes residues can be incorporated into the soil to improve the soil fertility status. In order to meet the complete nutrient requirement of maize, combined use of organic and chemical

fertilisers should be adopted for achieving potential yields of maize. Earlier researchers stated that grain yield of maize was higher when leguminuous cover crops were incorporated (Tanimu *et al.,* 2007).

## Crop residue management of legumes effect on growth and yield of succeeding maize

### Growth Parameters of maize

Onwonga *et al.,* (2014) conducted two experiments at Njoro and Molo on soils of mollic Phaeozems and mollic Andisols, respectively and reported that drymatter yield of maize was higher with *Crotalaria* rotation, followed by cowpea when compared to natural fallow.

Shuaibu *et al.,* (2015) reported that incorporation of legume residues of soybean and cowpea resulted in increased plant height of maize when compared to fallow at Abubakar Tafaka Balewa University, Bauchi, Nigeria.

The plant height of maize at 8 and 10 WAP produced taller plants in cowpea green manure treated plots than the control as per the research findings carried out at the University of Agriculture, Abeokuta, Nigeria by Fabunmi and Balogun, 2015.

Zero tillage and permanent bed tillage in maize-chickpea-Sesbania crop rotation resulted in higher leaf area index and net assimilation rate when compared to conventional tillage from the findings of Yadav *et al.,* (2017) at ICAR-IIMR, New Delhi. Mehran Ali *et al.,* (2018) conducted an experiment at the University of Agriculture, Peshawar and observed that various nitrogen sources and mungbean residues incorporated with mould board plough resulted in higher biological yield than control in maize.

### Yield attributes and yield of maize

The results with regard to hundred seed weight, harvest index and total seed yield of corn were highest with incorporation of cowpea residues of different varieties and are comparable with fertilizer applied plots as per the field experiment results conducted at Ghana on soils of Ferric Acrisols by Fataah and Addo (2016).

Parihar *et al.,* (2016) from six year study on conservation agriculture trail with retention of 30 per cent crop residues along with 100 per cent retention of *Sesbania* crop residue in intensive irrigated maize systems found that crop productivity increased in maize-mustard-mungbean and maize-wheat-mungbean systems at Indian Institute of Maize Research (ICAR), New Delhi.

Highest cob length and maize yields were recorded with *Eupatorium* mulching (3.87 t $ha^{-1}$) followed by soybean green manure incorporation insitu + one hand weeding (3.64 t $ha^{-1}$) under rainfed organic farming system of maize production in sandy clay loam soils of mid hills of Meghalaya (Anup Das *et al.,* 2016).

Biomass of corn and yield parameters like shelling percentage and harvest index were enhanced with application of *Cajanus cajan* mulch @ 5 t ha-1which is comparable to the NPK treated plot. The grain yield was highest with NPK during dry season while in wet season *Cajanus cajan* mulch produced higher corn yields on clay loam alfisol at Nigeria (Awopegba *et al.,* 2016).

Broad bed furrow and flat bed with no tillage along with retention of crop residues on the soil surface combined with inorganic fertilisers and FYM produced maize equivalent yields of 7914 and 7786 kg $ha^{-1}$ respectively, when compared to incorporation

and conventional tillage with enhanced yields for all the cropping systems of groundnut-sorghum, soybean-wheat and maize-chickpea from the experimental findings of Prabhamani and Babalad, 2017 at UAS, Dharwad.

Corn yield of 37,290 kg ha-1 was obtained with soybean residue along with supplemental dose of phosphorus and potassium fertiliser which was found similar to inorganic fertiliser treated plot as per the research findings of Almaz *et al.*, 2017 at Malaysia.

Maize protein yield and maize protein yield for adults recorded maximum with conservation tillage (Zero tillage and permanent bed) under legume based maize rotation when compared to conventional tillage and the highest values was with Maize-chickpea-*Sesbania* cropping system (Yadav *et al.*, 2017).

Kalasa *et al.*, 2018 from the study carried at Kandeu and Manjawira Extension Planning areas, Central Malawi observed that maize grain yields following incorporation of legume crop residues were significantly higher than continuous sole cropped maize. The maize equivalent yields were maximum with maize-wheat-mungbean when compared to maize-lentil-mungbean under conservation tillage with retention of crop residues in the plots on light textured soil of Nepal (Hari Kumar *et al.,* 2018).

Mulching and incorporation of cowpea residues resulted in maximum number of ears and 100 kernel weight with highest grain and stover yield of corn in maize-cowpea intercrops over no crop residue.

Among crop residue management, incorporation performed better for yield parameters and yield of corn than surface mulching of cowpea residues at Mtwapa, Kenya (Ndiso *et al.*, 2018).

Jat *et al.*, 2019 from their long term study recorded 10.1 to 16.7 % of maize crop grain yields with full conservation tillage of residue retention than the plots where residues were removed under maize-mustard-mungbean and maize-wheat-mungbean crop rotations.

## Responsiveness of maize to fertilizer application

Adesoji *et al.*, (2013) from the experiment conducted at Nigeria reported that at a given N rate, legume green manure produced significantly higher grain yield than weedy fallow. At a given legume green manure, increasing N rate beyond 60 and 90 kg N $ha^{-1}$ did not produce significant differences in grain yield. However, green manures *Mucuna*, lablab and soybean responded to application of 60 kg N $ha^{-1}$ in increasing yields of maize.

Shuaibu *et al.*, (2015) at Nigeria found that application of 60 kg N $ha^{-1}$ as a top dress to sorghum grown on cowpea or soybean residue increased the grain yields of sorghum. Sorghum intercropped with soybean left to maturity with nitrogen applied at 40 kg N $ha^{-1}$ resulted in higher soil $NO_3$-N along with increased grain yields at Kenya (Kebeney *et al.*, 2015).

Fataah and Addo, 2016 from the field experiment conducted at Ghana reported that cowpea variety Asetenapa residue incorporated plot showed the greatest yield which was comparable with the yields obtained from the fertilized plots. It suggested that incorporation of cowpea residues does not require application of chemical fertilizer.

Daramy *et al.*, (2017) at KNUST, Ghana reported that all the plots which were expected to contain residual N and P from previous season produced similar maize growth and yield with the plots that did not

receive N and P fertilizers from previous season but had incorporated cowpea residues as means of fertilization which implies that recycling of grain legume residues after harvest can produce net nitrogen as high as 140 kg N $ha^{-1}$ depending upon the legume.

Kalasa *et al.,* (2018) from the experiment conducted at Ntcheu district of Central Malawi concluded that the average maize grain yields following legume cropping systems were comparatively higher than maize grain yields from maize without nitrogen addition from inorganic fertilizers.

It was found that sole groundnut, top dressed with 23 kg N $ha^{-1}$ was higher (3352 kg $ha^{-1}$) compared to maize fertilized with 92 kg N $ha^{-1}$ (3159 kg $ha^{-1}$) which implies that organic matter addition from legumes with low nitrogen inputs from inorganic fertilizers is a viable option in improving maize grain yield.

## Nutrient uptake

The research findings of Shafi *et al.,* (2010) found that mulch and residue incorporation improved maize stover N uptake by 2.23 and 6.58% in maize crop at Peshawar, Pakistan.

Incorporation of cowpea residues and herbaceous legumes to sorghum resulted in significantly higher nitrogen content in sorghum than that of control at 6 WAI (Usman, 2013) on Ultisols at Guinea.

Kouelo *et al.,* (2013) from an experiment conducted on degraded sandy soil at National Institute of Agricultural Research, Benin observed that *Mucuna* residues incorporation increased grain nitrogen uptake (149.4 kg N $ha^{-1}$) when compared to no residue incorporated plot.

Total uptake of nutrients (N, P, K) by maize crop was more in crop residue incorporated plots than without residue incorporation plots on sandy loam soil at BAU, Ranchi (Asha Kumari *et al.,* 2018).

## Soil microbial biomass and activity

Awanish Kumar *et al.,* (2017) with four cropping systems along with reduced tillage, no tillage and conventional tillage found enhanced dehydrogenase activity (122.35 µg TPF $g^{-1}$ $day^{-1}$) with no tillage while fluorescein diacetate hydrolysis activity was more with reduced tillage (30.85 µg fluorescein $g^{-1}$ $h^{-1}$) in soybean+pigeonpea and maize-gram cropping systems.

Maize-chickpea-*Sesbania* with permanent bed and zero tillage by retention of 30 % crop residues on soil surface has dehydrogenase activity of 39.6 and 24.5 % in 0-5 and 5-15 cm depth of soil respectively, which were higher than conventional tillage and lower values were with maize-mustard mungbean (Amresh Chaudhary *et al.,* 2017).

Soil microbial biomass C and N recorded higher values (3.86 and 1.60 mg $kg^{-1}$) at 10 cm depth of soil with no-tillage when compared to chisel tillage with four crop rotations among which corn-soybean has slightly higher values (Zuber *et al.,* 2018).

Banda *et al.,* (2018) revealed that in maize-cowpea rotation system the soil microbial biomass carbon was higher which ranged from 1.96 to 2.28 mg/g on Acrisols and Alisols in Chipata District, Zambia.

Maize-wheat-mungbean crop rotation with zero tillage along with crop residue retention resulted in 56% and 70% microbial biomass carbon and nitrogen respectively, 73% and 40% of phosphatise activity and β-glucosidase activity respectively and fungal diversity in comparison with rice-wheat system (Madhu Choudhary *et al.,* 2018).

## Economics

Meena *et al.,* 2015 reported that under conventional tillage system, residue retention of greengram significantly increased the benefit-cost ratio (1.985) with a net profit of 11,543 Rs $ha^{-1}$ in maize based cropping systems.

Parihar *et al.,* (2016) concluded that zero tillage system of Maize-Mustard-Mungbean gave significantly higher net profits in first and sixth year of study while in the rest of the years, Maize-Wheat-Mungbean system resulted in highest net returns.

Prabhamani and Babalad, 2017 concluded that surface retention of crop residues with no tillage and flat bed method resulted in net profit of Rs 60654 $ha^{-1}$over incorporated and conventional tillage.

Naab *et al.,* 2017 from the analysis of partial budget by retention of crop residues in zero tillage system of maize-soybean rotation found that cost of production for maize or soybean is 20-29% cheaper with highest returns and Benefit-cost ratio when compared to conventional tillage.

Hari Kumar *et al.,* 2018 concluded that retention of crop residues under no tillage gave 114% higher net returns (NRs 40200 $ha^{-1}$) under maize based cropping system at Nepal.

From the above reviews, it can be concluded that, incorporation or mulching of crop residues proved to improve the performance of succeeding crops which is reflected in terms of growth and accumulation of drymatter. Significant response was also observed in yield attributes and yield of succeeding crop due to increased fertility status of soil and uptake of nutrients by the crop when compared to residue removal plots. Soil microbial activity was improved due to placement or incorporation of residues over residue removed treatments. Incorporation or mulching of legume crop residues also resulted in higher net returns and benefit-cost ratio.

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