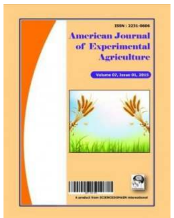

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Impact of Preceding Legume and Nitrogen Levels on Maize-preliminary Year Study

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Authors' contributions

This work was carried out in collaboration between all authors. All authors read and approved the final manuscript.

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Short Communication

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ABSTRACT

An experiment on maize crop with preceding legumes and nitrogen levels were carried out at the Research Farm of Agronomy, the University of Agriculture, Peshawar during 2011-2012 using summer legumes-maize cropping pattern. The summer legumes were sown in the summer gap (60-65days) for grain, fodder and green manure purposes. Mungbean for grain and cowpea for fodder purpose and Sesbania was for green manure purpose using fallow as control. After legumes experiment each plot was split into four sub plots to accommodate four levels of N (0, 90, 120 and 150 kg ha^{-1}) for maize. Data were recorded on emergence, plant height, grains ear^{-1} and ear weight. Soil parameters after legumes; pH, total soluble salts (TSS), electrical conductivity (EC), and calcium carbonate ($CaCo_3$) were not significantly affected by preceding legumes. Soil pH was higher in fallow plots while lower in plots previously cultivated with mungbean. Soil TSS, EC and $CaCo_3$

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were higher in plots previously sown with mungbean compared with fallow plots. All the parameters under investigation were significantly affected by nitrogen levels except maize seed emergence. In legumes the plots previously sown with cowpea and mungbean significantly affected grain per ear and ear weight of maize. Taller plants were produced in plots where N was applied at the rate of 150 kg ha^{-1} followed by N application of 120 kg ha^{-1}while control plots resulted in short stature plants. Plots fertilized with high N (150 kg ha^{-1}) had significantly higher ear weight which was at par with N application at the rate of 120 kg ha^{-1}. Higher grains per ear was recorded in plots treated with 120 kg ha^{-1} N which was at par with plots fertilized with 150 $kgha^{-1}$N. Control plots resulted in fewer grains ear^{-1}. It is concluded from the results that plot previously sown with legume performed better than fallow and the use of legumes in cropping system will be a good strategy for sustainability in feature.

Keywords: Maize; legumes; soil fertility and nitrogen levels.

1. INTRODUCTION

Cereal based cropping systems are predominantly practiced in Pakistan because of higher productivity, profitability and for ensuring food security. Previously, balanced fertilization with N, P and K were thought to be essential for achieving high levels of productivity. However, with the passage of time, there is a gradual decline in factor of productivity and increasingly higher doses of nutrients are required to be applied to achieve the potential yields of these crops. This situation is associated with deteriorating fertility of the soils and consequent emergence of multiple nutrient deficiencies including those of micronutrients [1]. Organic matter is the life of soil, and the practices that support organic matter build-up also favor sustainable productivity [2]. Incorporation of plant residues is a useful means to sustain organic matter content and thereby enhance the biological activity, improve soil physical properties and increase nutrient availability [3]. Organic manuring by application of conventional farmyard manure, mulching or green manure has declined over the years due to various operational constraints [4]. Cultivation of legumes for seed, fodder or green manure helps in sustaining the productivity of cereal based cropping systems and improves soil fertility through nutrient cycling [4].

In most parts of Pakistan, there is a hot summer period of 70–80 days which occurs from last week of April to mid July, a period between after wheat harvesting and before maize planting. This period can be utilized by short duration legume crops for enhancing grain legumes production or fodder availability or green manuring. Green manuring with annual leguminous crops like Sesbania is a widely known practice has been found beneficial not only for realizing potential yields but also for N economy and improving soil fertility [5]. Likewise, mungbean as well as cowpea have direct value in human diet and potential in adding N to the cropping system, especially when their residues with nodules are incorporated into the soil [6].

It is not only desirable but quite possible to reduce the reliance on synthetic N fertilizers and move towards greater use of legumes to supply N for crop production. In fact, legume-based systems are likely to be more sustainable than cereal-based or fertilizer based systems. There are few studies quantifying the relative contribution of legumes in summer gap towards N economy, productivity, profitability and soil fertility in cereal based cropping system [3]. Hence, a comprehensive study was undertaken to determine the immediate and residual effects of legumes on soil fertility and maize performance in cereal based cropping system.

1.1 Objective

- To investigate optimum level of nitrogen for maize crop.
- To enhance overall farm productivity with summer gape utilization.
- To reduce reliance on synthetic N.

2. MATERIALS AND METHODS

The experiment was conducted at The Agronomy Research farm, the University of Agriculture Peshawar during 2011-2012 in kharif season. The experimental farm is located at 34.01° N latitude, 71.35° E longitude, at an altitude of 350 m above sea level in Peshawar valley. Peshawar (34.0167° N and 71.5833° E) is located about 1600 km North of the Indian Ocean and has continental type of climate. The research farm is irrigated by Warsak canal from river Kabul. Soil is clay loam, low in organic matter (0.87%), nitrogen (0.03%), phosphorus (6.57 mg kg^{-1}), potassium (121 mg kg^{-1}) and alkaline (pH 8.2) and is calcareous in nature [7]. Summer legumes-maize cropping pattern was used for the experiments. The summer legumes were adjusted in planted during the period between after wheat harvesting and the planting of maize for grain, fodder and green manure purposes. Mungbean for grain, cowpea for fodder and Sesbania was purely for green manure production. A natural fallow was included in the experiment as control. After the harvest of wheat crop, summer legumes i.e. cowpea (Vigna unguiculata, cv. Ebony), mungbean (Vigna radiate, cv. NIAB-2006) and sesbania (Sebania aculeate, cv. Pashawari) were sown in the first week of May according to the recommended agronomic practices. All the legumes seed were treated with native Rhizobium sp before sowing. A starter dose of NPK fertilizer 25-45-25 kg ha^{-1} were applied before sowing of legumes. The biomass of Sesbania was incorporated into the field with a disc harrow in early July.

After thorough land preparation, each plot from the previous legumes was split into four sub plots to accommodate four levels of N to maize crop. Maize was sown with four levels of N fertilizer (0, 90, 120 and 150 kg ha^{-1}) in mid July and wheat with (0, 60, 90 and 120 kg ha^{-1}) in mid November. Nitrogen as urea was applied to maize and wheat in two equal splits, half at sowing and another half at 30 days of growth. Similarly, the recommended rate of P fertilizer 90 kg ha^{-1} was applied to maize at sowing stage. For the legume experiment, a randomized complete block design (RCBD) with four replications was used in a plot size of 5 m x 16 m. For maize experiment, the plot (5 m x 16 m) was split into four plots to accommodate four levels of N to maize. In this way, each subplot size was 5 m x 4 m. Data were recorded on emergence per meter square by counting total number of plants that emerged in one meter row length at three randomly selected rows in each sub plot and then converted to emergence m^{-2}. Plant height of each crop was measured from base to the tip of the plant and five randomly selected plants in each sub-plot were used. Grains per ear of five randomly selected ears was counted and averaged.

For the analysis of soil physio-chemical characteristics, three soil samples were taken from each subplot at random and were mixed together for the determination of different physiochemical properties of soil (pH, EC, total soluble salts (TSS) and $CaCo_3$). Soil sampling was done after the harvest of legumes. Physico- chemical properties by the following standard procedures. pH, EC, total soluble salts (TSS) and $CaCo_3$ were determined according to [8,9].

2.1 Statistical Analysis

The data were analyzed according to analysis of variance technique appropriate for RCB design for legume experiment and RCB design with split plot arrangement for maize and wheat experiments using Genstat discovery software. The treatment means were compared at $P<0.05$ level of probability using LSD test [10].

3. RESULTS AND DISCUSSION

Cow pea and Sesbania produce 16612 and 12492 kg ha^{-1} fresh biomass with 6.2 and 5.1 g kg^{-1} of nitrogen respectively. Similarly mungbean produce 595 kg ha^{-1} of seed yield and fallow plots produce mainly grass as natural vegetation.

3.1 Soil Parameters after Legumes Experiment

The values of the soil pH, total soluble salts (TSS), electrical conductivity (EC) and $CaCo_3$ content were not significantly affected by preceding legumes (Table 1).

3.2 Maize Seedling Emergence

Statistical analysis of the data showed that nitrogen levels (N) and legumes (L) had non-significant effects on emergence m^{-2}. The N x L interaction was also not significant (Table 2).

3.3 Plant Height

Different nitrogen levels significantly affected maize plant height while the effect on legume cropping system remained not significant (Table 2). The Nitrogen x Legumes interaction on maize height was not significant. Plant height increased as nitrogen level increased from 0 to 150 kg ha^{-1}. The tallest maize plants (206 cm) were recorded in plots where N was applied at the rate of 150 kg ha^{-1} (Table 2) followed by that 120 kg ha^{-1} (202 cm), while control plots recorded the shortest (188 cm) maize plants. This increase in plant height could be attributed to positive effect of N on vigorous vegetative growth. The results are in agreement with the finding of [11] who reported that maize growth increased with increasing nitrogen fertilizer.

3.4 Ear Weight (g)

Ear weight of maize was significantly affected by nitrogen levels and previously grown legumes (Table 2). Cowpea and mungbean enhanced ear weight of maize than previous sesbania and fallow.

The N x L interaction was not significant. Linear increase was observed in ear weight of maize as N level increased. Plots fertilized with high N (150 kg ha^{-1}) had significantly higher ear weight (75 g) which was at par with nitrogen application at the rate of 120 kg ha^{-1} as compared to control plots (54 g). Our finding are in line with the observation of [12] who reported that nitrogen application have positive relation with yield of maize. Similarly, ear weight was higher in plots previously sown with cowpea or mungbean. Increase in ear weight is due to effect of preceding legumes which might increase the availability of essential nutrient for plant growth. Similar results are also reported by [13] that Sesbania green manuring and legumes in cropping system have favorable effect on maize yield and yield attributes.

3.5 Grains Ear^{-1}

Data on grains ear^{-1} is presented in Table 2. Statistical analysis of the data indicated that nitrogen levels significantly affected grain ear^{-1} of maize while the effect of legumes were not significant. Similarly, N x L interaction remained not significant. Grains ear^{-1} increased as N increased from 0 to 120 kg ha^{-1}. Higher grains ear^{-1} were found in ears collected from plots treated with N at the rate of 120 kg ha^{-1} which was at par with plots fertilized with N at the rate of 150 kg ha^{-1}. Control plots resulted in fewer grains ear^{-1}. All N amended plots resulted in higher grain ear^{-1} over control. Timely availability of nutrient mainly N in N amended plots increased in dry matter accumulation and better crop growth that could positively change the physiological functions of the maize crop [14].

Table 1. Soil pH, TSS, EC and $CaCo_3$ as affected by preceding legumes

Legumes	pH	TSS (%)	EC ($dS.m^{-1}$)	CaCO3 (ppm)
Cowpea	8.200	0.060	0.187	12.833
Mungbean	8.167	0.066	0.207	12.917
Sesbania	8.167	0.059	0.183	13.250
Fallow	8.233	0.053	0.167	12.000
LSD(0.05)	ns	Ns	Ns	Ns

Means in the same column followed by different latter are significantly different from one another at 5% level of probability; ns = non-significant

Table 2. Emergence m^{-2}, plant height (cm), ear weight (g) and grains ear^{-1} of maize as affected by different nitrogen levels and preceding legumes

	Emergence m^{-2}	Plant height (cm)	Ear weight (g)	Grains ear^{-1}
Legumes				
Cowpea	11	205	77 a	259 a
Mungbean	11	201	74 a	263 a
Sesbania	10	191	63 b	242 b
Fallow	11	193	60 b	244 b
LSD (0.05)	Ns	Ns	9.23	13.54
Nitrogen (kg ha^{-1})				
0	10	188 d	54 c	234 c
90	11	195 c	64 b	252 b
120	11	202 b	77 a	264 a
150	11	206 a	79 a	257 ab
LSD (0.05)	Ns	3.54	4.12	14.68

Means of the same category followed by different letter(s) are significantly different from one another at 5% level of probability; ns = non-significant

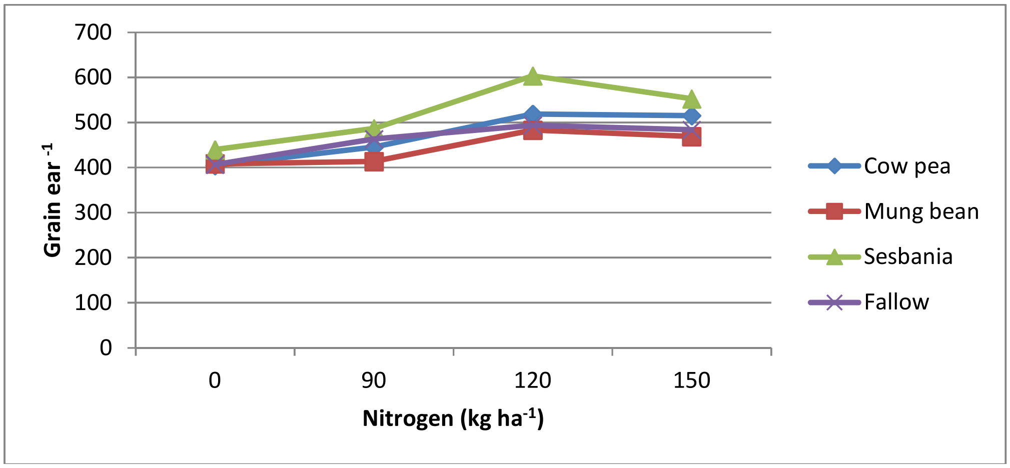

Fig. 1. Grains ear^{-1} of maize as affected by different nitrogen levels and preceding legumes

4. CONCLUSIONS AND RECOMMENDATION

It is concluded from the above results that maize yield parameter was significantly higher in preceding summer legumes plots as compared to control fallow plots. Similarly plots fertilized with nitrogen level 120 kg ha^{-1} produce similar or higher ear weight and grain per ear than recommended dose of 150 kg ha^{-1}. Mean inclusion of legumes in cropping system is beneficial for improving form productivity and on long term basis will improve soil fertility and reducing fertilizer cost.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Timsina J. Quayyum MA, Connor DJ, Saleque M, Haq F, Panaullah GM, Jahan M, Begum RA. Effect of fertilizer and mungbean residue management on total productivity, soil fertility and N-use efficiency in intensified rice–wheat systems. Int. J. Agric. Res. 2006;1(1): 41-52.
2. Katyal JCN, Rao H, Reddy MN. Critical aspects of organic matter management in the tropics. The Example of India. Nutr. Cycl. Agro-Ecosyst. 2001;61(4):77-88.
3. Arif M, Malik MA. Economic feasibility of proposed cropping patterns under different moisture regimes of Pothwar plateau. Int. J. Agric. Biol. 2014;11:27-32.
4. Herridge DF, Marcellos H, Felton WL, Truner GL, Peoples MB. Chickpea increases soil-N fertility in cereal systems through nitrate sparing and N2 fixation. Soil Biol. Biochem. 1995;27(3):545-551.
5. Singh Y, Khind CS, Singh B. Efficient management of leguminous green manures in wetland rice. Adv. Agron. 1991;45(1): 135-189.
6. Glasener KM, Wagger MG, Mackown CT, Richard JV. Contributions of shoot and root nitrogen-15 labeled legume nitrogen sources to a sequence of three cereal crops. Soil Sci. Soc. Am. J. 2002;66(2):523-530.
7. Amanullah, Khattak RA. Khalil SK. Effects of plant density and N on phenology and yield of maize. J Plant Nutr. 2009;32:245-259.
8. Mclean EO. Soil pH and line requirements. In methods of soil analysis, part 2. Chemical and Microbiological Properties. Ag; 1982. Monograph No. 9, 2nd edition.
9. Koehler FE, Moudre CD, McNeal BL. laboratory manual for soil fertility. Washington State University Pluman, USA; 1984.
10. Jan MT, Shah P, Hollington PA, Khan MJ and Sohail Q. Agriculture Research: Design and Analysis. A Monograph. NWFP

Agricultural University Peshawar, Pakistan; 2009.

11. Khan A, Jan MT, Marwat KB, Arif M. Organic and inorganic nitrogen treatment effect on plant and yield attributes of maize in a different tillage system. Pak. J. Bot. 2009;41(6):99-108.
12. López-Bellido L, López-Bellido RJ, Redondo R. Nitrogen efficiency in wheat under rainfed Mediterranean conditions as affected by split nitrogen application. Field Crops Res. 2007;94:86-97.
13. Sharma AR, Behera UK. Nitrogen contribution through *Sesbania green* manure and dual-purpose legumes in maize-wheat cropping system: Agronomic and economic considerations. Plant and Soil J. 2009;325(5):289-304.
14. Ali M. Effect of summer legumes on productivity and nitrogen economy of succeeding rice (*Oryza sativa*) in sequential cropping. Indian J Agric. Sci. 1992;62(7): 466-467.

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