

Original Research Paper

Effects of Preceding Legumes and Nitrogen Fertilizer on Soil Fertility and Growth Attribute of Maize

ABSTRACT

An experiment to determine the effects of preceding legumes and nitrogen levels on soil fertility and maize growth and yield attributes was carried out in-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 (land available after wheat harvest till maize sowing) 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, 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-m⁻², plant height, grains ear⁻¹ and ear weight. Soil parameters after legumes; pH, total soluble salts-(TSS), electrical conductivity-(EC), and calcium carbonate (CaCO₃) were not significantly affected by preceding legumes. [G. 0.1] Soil pH was higher in fallow plots and lower in plots previously cultivated with mungbean. Soil TSS, EC and CaCO₃ were higher in plots previously sown with mungbean compared with plots-left-fallow plots. All the parameters under investigation were significantly affected by nitrogen levels except maize seed emergence-m⁻² of maize. The effect of legumes was significant for grain ear⁻¹ and ear weight. [G. 0.2] 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 ear⁻¹ were found was recorded in ear-collected from plots treated with 120 kg [G. 0.3] ha⁻¹ N at the rate of 120 kg ha⁻¹ which was at par with plots fertilized with 150 kg ha⁻¹ N at the rate of 150 kg ha⁻¹. Control plots resulted in fewer grains ear⁻¹. It is concluded from 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 future.

Key words: Maize, legumes, soil fertility and nitrogen levels,

I. INTRODUCTION

Cereal based cropping systems are predominantly practiced in Pakistan because of higher productivity, and profitability, and for ensuring food security. Previously, fertilization with N, P and K were thought to be essential for achieving high levels of productivity. However,

34 with the passage of time, there was a gradual decline in factor of productivity and increasingly
higher

35 doses of nutrients are required to achieve the potential yields of crops. This

36 situation is associated with deteriorating fertility of the soils and consequent emergence of

multiple nutrient deficiencies including those of micronutrients. Organic matter is the life of soil, and the practices that support organic matter build-up also favor sustainable productivity (Katyal *et al.*, 2001). 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. (Arif *et al.*, 2014). Organic manuring by ~~way of direct~~ application of conventional farmyard manure, mulching or green ~~manuring manure~~ has declined over the years due to various operational constraints [G. O.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 (Herridge *et al.*, 1995).

In most parts of Pakistan, there is a hot summer period of 70–80 days available after the harvest of wheat till maize sowing from last week of April to mid July which 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 and found beneficial not only for realizing potential yields but also for N economy and improving soil fertility (Singh *et al.*, 1991). Likewise, mungbean, as well as cowpea, have direct value in human diet and potential to add N to the cropping system, especially when their residues with nodules are incorporated into the soil (Glasener *et al.*, 2002).

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. Hence, this ~~constraints. S~~ study was undertaken to determine the immediate and residual effects of legumes on

60 on soil fertility and maize performance in cereal based cropping system.

62 II. MATERIALS AND METHODS

63 The experiments were conducted at the Agronomy Research Farm, the University of
64 Agriculture, Peshawar during 2011-2012. Summer legumes-maize cropping pattern was followed
65 for the experiments. The summer legumes were adjusted in the summer gap (land available after
66 wheat harvest till maize sowing) for grain, fodder and green manure purposes. Mungbean was
67 used for grain purpose, and cowpea was used for fodder purpose. Likewise, and Sesbania
sesbania was purely

68 used for green manure purpose. A natural fallow [G. o.5] was included in the experiment as control.
The legumes

69 were mungbean (grain purpose), cowpea (fodder purpose), Sesbania (green manure) and fallow

70 land. After the harvest of uniformly grown wheat crop, summer legumes i.e. mungbean, cowpea

71 and Sesbania were sown in the first week of May following recommended agronomic practices.

[G. o.6] 72 The biomass of Sesbania was incorporated into the field with a disc harrow in early July.

73 After thorough land preparation [G. o.7], each plot of the previous legumes experiment was
split

74 into four sub plots to accommodate four levels of N to maize crop. Maize was sown with four

[G. o.8] 75 levels of N fertilizer (0, 90, 120 and 150 kg ha⁻¹) in mid July. Nitrogen as urea was
applied to maize

76 in two equal splits, half each at sowing and 30 days after planting. Similarly, the

77 recommended rate of P fertilizer at the rate of (90 kg ha⁻¹) was applied to maize at sowing. For
the legume's experiment

78 randomized complete block design with four replications was used. [G. o.9] A plot size of 5 m x
16 m

79 was used. For maize experiment, the plot of the previous legume's experiment was split into four

80 plots to accommodate four levels of N to maize. In this way, the subplot size was 5 m x 4 m.

81 Data was recorded on emergence m⁻² by counting total number of plants that emerged in one
meter

82 row length at three randomly selected rows in each sub plot and then converted to emergence m⁻²

90 Statistical analysis

83 91 The data were analyzed according to analysis of variance technique
 84 92 design for legume experiment and RCB design with split plot arrangement for
 randomly selected plants in each sub-plot. Grains ear⁻¹ of five randomly selected ears was

85 93 experiments using Genstat discovery software. The treatment means was
 counted and averaged. P<0.05

86 94 level of probability using LSD test (Jan *et al.*, 2009).
 For recording soil physio-chemical characteristics, three soil samples were taken from

95 IV. RESULTS AND DISCUSSION

87 96 in each soil subplot at random and were mixed together for the determination of
 different [G. O.10] 96 Soil parameters after legumes experiment

88 97 Soil pH, total soluble salts (TSS), electrical conductivity (EC) and
 different physical and chemical properties of soil including pH, EC, total soluble salts (TSS) and CaCO₃

89 98 significantly affected by preceding legumes (Table 1).
 content. Soil sampling was done after the harvest of legumes.

Maize seedling emergence m⁻²

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

107 Plant height (cm)

108 Previous legumes had no significant effect on plant height of maize but nitrogen levels
 significantly affected plant height of maize (Table 2). Nitrogen x Legume interaction on
 maize height was not significant. Plant height increased as nitrogen level increased from 0
 to 150 kg ha⁻¹. Taller plants (206 cm) 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 (202 cm), while control plots resulted in short stature
 113 plants. This increase in plant height could be attributed to positive effect of N on vigorous
 114 vegetative growth. The results are in agreement with the finding of Khan *et al.* (2009) who
 115 reported that maize growth increased with increasing nitrogen fertilizer.

117 Ear weight (g) [G. O.11]

118 Ear weight of maize was significantly affected by previous legumes and nitrogen levels
 (Table 2).

Previous cowpea and mungbean [G. O.12] enhanced higher ear weight of maize than previous
 sesbania and fallow.

119 The N x L interaction was not significant. Linear increase was observed in ear weight of maize
120 as N level increased. Plots fertilized with high N (150 kg ha⁻¹) had significantly higher ear
121 weight (75 g) which was at par with nitrogen application at the rate of 120 kg ha⁻¹ as compared
122 to control plots (54 g). Our findings are in line with the observation of Lopez *et al.* (2007)
who reported that nitrogen
123 application have positive relation with yield of maize. Similarly, ear weight was higher in plots
124 previously sown with cowpea or mungbean.

126 Similar results ~~are~~were also reported by Sharma *et al.* (2009) that Sesbania green manuring
and
127 legumes in cropping system have favorable effect on maize yield and yield attributes.

128 **Grains ear⁻¹**

129 Data on grains ear⁻¹ is presented in Table 2. Statistical analysis of the data indicated that
 130 nitrogen levels significantly affected grain ear⁻¹ of maize while the effect of legumes was not
 131 significant. Similarly, N x L interaction remained not significant. Grains ear⁻¹ increased as N
 132 increased from 0 to 120 kg ha⁻¹. Higher grains ear⁻¹ were found in ears collected from plots
 133 treated with N at the rate of 120 kg ha⁻¹ which was at par with plots fertilized with N at the rate
 134 of 150 kg ha⁻¹. Control plots resulted in fewer grains ear⁻¹. All N amended plots resulted in
 135 higher grain ear⁻¹ over control. Timely availability of nutrient mainly N in N amended plots
 136 increased dry matter accumulation and better crop growth that could positively change the
 137 physiological functions of the maize crop (Ali *et al.*, 1999).

138

139 Table1. Soil pH, TSS, EC and CaCO₃ as affected by preceding legumes.

140

Legumes	pH	TSS (%)	EC (dsm ⁻¹)	CaCO ₃ (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

141 Means in the same column followed by different latter are significantly different from one
 142 another at 5% level of probability.

143 ns = non-significant

144

145

146 Table 2. Emergence m⁻², plant height (cm), ear weight (g) and grains ear⁻¹ of maize as affected
 147 by different nitrogen levels and preceding legumes.

Legumes	Emergence (no of plants m ⁻²)	Grains ear ⁻¹	Plant height (cm)	Ear weight
	(g) [G. 0.13]	[G. 0.14]		
Cowpea	11	205	77a	259 a
Mungbean	11	201	74a	263 a
Sesbania	10	191	63b	242 b
Fallow	11	193	60b	244 b
LSD (0.05)	ns	ns	9.23	13.54

Nitrogen (kg ha ⁻¹)				
0	10	188 d	54c	234 c
90	11	195 c	64b	252 b
120	11	202 b	77a	264 a
150	11	206 a	79a	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

Conclusions and recommendation

It is concluded from the above results that summer legumes increase the availability of soil nutrient reduce nutrient losses, reduce fertilizer cost and thus have the continuous use of the system will improve the yield of maize on sustainable basis in feature.

[G. O.15]

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