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Emergence and Nitrogen Use Efficiency of Maize under Different Tillage Operations and Fertility Levels

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Abstract: The field experiment was conducted at Students Farm, Sindh Agriculture University, Tandojam, Pakistan to observe the emergence of maize and nitrogen use efficiency of the crop under different fertility regimes (0-0, 90-00, 90-60, 90-90, 90-120, 150-00, 150-60, 150-90 and 150-120 NP kg ha^{-1}) applied in the plots plowed through tillage practices with cultivator, chisel and desi plows. The better emergence was obtained with 90-90 NP kg ha^{-1}. The seedling emergence decreased at higher doses of N and P. The interaction of tillage× fertilizer revealed that fertilizer at the rate of 90-150 kg ha^{-1} and tillage practices with cultivator exhibited higher seedling emergence, while the plots ploughed with chisel plow and desi plow recorded decreased emergence. However, chisel plowing recorded higher fertilizer nitrogen use efficiency than the plots ploughed by cultivator or desi plough. Nitrogen use efficiency at high levels of nitrogen applications was low than in the low rates of N incorporation. It was concluded that tillage practices should be performed with cultivator and 90 kg N ha^{-1} is suitable combination for seedling emergence and crop yield of maize.

Key words: Tillage, cultivator, chisel, desi, plows, maize, corn, nitrogen, phosphorus, fertilizers, emergence

INTRODUCTION

Pakistan stands very low in respect of area and production under maize cultivation. This crop is being grown on an area of about 941.6 and 5.5 thousands ha^{-1} with an average yield of 1768 and 582 kg ha^{-1} in Pakistan and Sindh respectively (Anonymous, 2003). On a world basis maize occupies third position in the world production of cereals as a human diet, livestock feed and industrial processing. Stalks of maize are used for papers board, husks are used as filling material, cobs are used for fuel make, charcoal and preparation of industrial solvents. Maize fodder is good for all types of animals. When entire plant is used for forage it exceeds all other forage crops in average yield, dry matter and digestible nutrient. Green maize forage is high in vitamins-A. The green fodder contains 1.56% protein, 0.30% fat and 5.27% fiber (Chaudhry, 1982).

To enhance the present production level of maize, it is necessary to adopt proper package of technology and various agronomic practices. Application of tillage operation and nutrients play important role in the development of maize production and crop parameters especially emergence. The magnitude of nutrient stresses is so severe and widespread that no single remedial measure can effectively solve this problem. For example, it is estimated that as much as 8-26 million ha of maize, at least 60% of beans in Latin America and approximately 44% of beans in Africa, are grown on soils that are severely deficient in phosphate (Yan *et al.*, 1996). Likewise, it is estimated that at least 50% of the arable land used for crop production worldwide is low in availability of one or more of the essential micronutrients for current varieties (Ruel and Bouis, 1997).

Maize emergence and growth directly and indirectly are influenced by tillage operations. Most of the farmers are using a locally made plough and due to continuous use of the plough lead to form a plough pan or compact soil which hinder root growth and seed emergence. Previous studies revealed that tillage operations has significant contribution in terms of increased yield. Sheikh *et al.* (1980) reported that disc harrow and sweep cultivator were efficient for seedbed preparation. Gordon *et al.* (1993) observed that N uptake by the crop was greater with ridging than the mould board or chisel plough. Arora *et al.* (1991) reported that deep tillage is beneficial for maize cultivation.

Most agricultural soils are deficient in nitrogen for the growth of crops. This deficiency can be overcome by the use of fertilizers, but fertilizer N is not being used efficiently and Nitrogen Use Efficiency (NUE) is not properly evaluated for different crops grown in different regions. NUE is the efficiency of acquisition (plant nutrient content/available nutrient) or the physiological

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efficiency with which a nutrient is used to produce biomass (plant biomass/plant nutrient content) or grain (grain yield/plant nutrient content). It is also the amount of additional grain yield per unit of fertilizer applied. The most efficient management practice to maximize plant uptake and minimize losses is to synchronize the N supply with the plant demand for this nutrient. This general concept of balancing supply and demand implies maintaining low levels of mineral N in soil when there is little or no plant growth and providing sufficient N to meet plant requirements during periods of rapid growth (Peoples *et al.* 1995). The integrated uses of fertilizers not only increase mutual efficiency but also help in the substitution of chemical fertilizers (Ghosh and Sharma, 1999; Anwar and Yousaf, 2000). A deficiency in secondary and micronutrients is another factor reducing N and P use efficiency. This is becoming more common in cropping systems worldwide. A good supply of secondary and micronutrients can improve the yield response to macronutrients considerably. In Malawi, for example, average maize yields improved by 40% as compared with the standard N-P recommendation when the deficiencies of B, Zn, S and K were satisfied (Kumwenda *et al.* 1996). Looking the facts of previous research, the field investigation was conducted for exploring techniques of ploughing operations and NP fertilizer regimes for obtaining satisfactory maize emergence and nitrogen use efficiency.

MATERIALS AND METHODS

The field experiment was laid-down at Student farm, Sindh Agriculture University, Tandojam to assess the appropriate plowing method, nitrogen and phosphorus doses for seedling emergence and nitrogen use efficiency. The plowing of soil was performed with cultivator, chisel and desi plows with the incorporation of 0-0, 90-00, 90-60, 90-90, 90-120, 150-00, 150-60, 150-90 and 150-120 NP kg ha^{-1}. Full phosphorus and half nitrogen levels were applied during sowing and remaining nitrogen was applied in two splits i.e. at second and third irrigations. The emergence determination (m^{-2}) was counted after full seed germination. Nitrogen use efficiency was determined by: (Grain yield)/(nitrogen supplied as fertilizer). All the other cultural practices were adopted to maintain the area. The data was statistically analyzed through MATATC package.

RESULTS AND DISCUSSION

Emergence: The emergence significantly of maize under different fertility regimes improved. The best emergence was obtained with 90 kg N and 90 kg P ha^{-1}. The high dose of N and P decreased the seedling emergence.

Table 1: Emergence of plants m^{-2} as affected by tillage and various fertilizer regimes

Treatments NP (kg ha^{-1})	Chisel plow	Cultivator plow	Desi plow	Mean
00-00	14.25c	11.73hij	11.49ij	12.49cd
90-00	16.27b	11.61ij	14.01c	13.96b
90-60	21.17fghi	11.68ij	11.25j	11.71d
90-90	18.31a	16.18	16.44b	16.98a
90-120	17.75a	15.91b	15.88b	16.51a
150-00	12.69efg	11.97ghij	11.56ij	12.70d
150-60	13.49cde	11.64ij	12.54fgh	12.56cd
150-90	13.91c	12.59fg	13.56cd	13.35bc
150-120	12.81def	11.59ij	11.91ghij	12.10d

Means of the same category followed by different letter(s) are significantly different at 5% level of probability using LSD test

	Tillage× nitrogen	Tillage× phosphorus	Tillage	Fertilizer	Tillage× fertilizer
LSD(5%)	0.42	0.58	0.56	1.07	0.83

Table 2: Nitrogen use efficiency as affected by tillage and various fertilizer regimes

Treatments NP (kg ha^{-1})	Chisel plow	Cultivator plow	Desi plow	Mean
00-00	-	-	-	-
90-00	38.18	40.02	38.31	38.84
90-60	67.73	67.02	68.03	67.59
90-90	70.07	71.37	68.58	70.00
90-120	73.12	72.57	69.01	71.56
150-00	26.54	25.13	26.00	25.89
150-60	47.60	42.77	44.04	44.81
150-90	40.76	39.56	39.98	40.10
150-120	40.81	38.66	39.62	39.69

The interaction of tillage×fertilizer revealed that the plots where cultivator was used, the emergence of subplots receiving 90 and 150 kg N ha^{-1} was about the same, while in the plots ploughed with chisel plow and desi plow, the higher rate of nitrogen decreased emergence (Table 1). Hussain (1987) also concluded that 100 kg N ha^{-1} produced maximum emergence in maize and increased plant elongation and yield (Jehan, 1989). Comparison of various tillage methods by Kersten and Hack (1991) indicated that best results could be achieved by plowing against no till cultivation.

Nitrogen Use Efficiency: The results revealed that plots plowed by chisel plough had higher fertilizer nitrogen use efficiency than the plots ploughed by cultivator or desi plough. The combination of nitrogen and phosphorus at the rate of 90-120 kg ha^{-1} increased the nitrogen use efficiency followed by 90-90 NP kg ha^{-1} (Table 2). Nitrogen use efficiency in the high nitrogen treatment was lower than in the low N treatment. According to Simonis (1988) that nitrogen use efficiency values generally decreased with increasing nitrogen at the rate of 160 kg ha^{-1}. These results also agree with the findings of Gordon *et al.* (1993) that the plant N uptake was greater with ridging than the mould board or chisel plough.

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