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RESEARCH ARTICLE

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A Sustainable Approach toward Maize Production: Effectiveness of Farm Yard Manure and Urea N

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ABSTRACT

Maize (Zea mays L.) is grown in north western Pakistan mostly in hilly area, where farmer use farm yard manure (FYM) or urea N for its production solely or in combination. To optimize the FYM and Urea-N for improved productivity, an experiment was carried out using three level of FYM, i.e., 0.5, 10, 15 t ha^{-1} either solely or in combination with 50 and/or 100 kg N ha^{-1} and was repeated during next year. A control plots having no FYM or urea N was also included. The management of FYM and inorganic N had a profound bearing on maize productivity and improved yield and yield traits. A linear increase in each yield and yield traits was observed with each increment in FYM at both levels of urea-N. Plants were taller in plots received FYM as well as urea N compared to sole FYM or control. Number of cobs/plants, grains/cob and thousand grain weight were linearly increased with the increase in levels of FYM at both levels of urea N. Plant stalk and grain yield was higher at maximum levels of both FYM and urea N. It was comprehend from the experiment that combined use of organic and inorganic N produce more than sole use of FYM and thus, is recommended for general cultivation in north western Pakistan on sustainable basis.

Keywords: Organic farming, Inorganic N, FYM, Grain yield, Maize

INTRODUCTION

Maize is third most important crops in term of its production and consumption after wheat (*Triticum aestivum* L.) and rice (*Oryza sativa* L.). Its production was increased by 46% during last decade since 2000 to 2007-2008, with only increase in area by 6% [1]; however with growing population its production needs to be increased to feed the ever growing human population. It is planting in two seasons, i.e., the spring season crop and the main summer crop. Both seasons' crops have durations of about 3-4 months. Mostly open-pollinated maize cultivars are sown in the area [2].

Researchers for example, Habtegebrial et al. [3] reported that crop fertilization had improved the soil physical and chemical properties, and thus crop production. The soil of the experimental site is deficient in organic matter [4] and therefore, the addition of farmyard manure can play a significant role in increasing crop productivity. Agricultural productivity can be improved on sustainable basis in arid and semi-arid areas through using the organic residue as reported [5] and combination of decomposable organic residues and N fertilizer [6]. Nitrogen fertilization had increased grain yield (43-68%) and biomass (25-42%) in maize [7] contributed 18-34% into soil residual nitrogen [8] in addition to 4-9.4% more mineralization from soil total N [9]. Synergistic effects of N with FYM accumulated more soil total N [10]. However, FYM alone had increased yield of maize [11], soil organic matter by 44% [12] and soil porosity as well as water holding capacity [13].

Manure incorporation is considered as a primary substrate for replenishment of soil organic matter [12,14] and can be regarded as an alternative way of adding fertilizer to increase soil fertility and crop productivity [15]. However, there is not enough information on the effect of manure application in addition to fertilizer N, particularly in silt clay loam soil of Pakistan. Therefore, an experiment was designed with the hypothesis to quantify the effects of FYM alone or in combination with urea N on maize productivity.

MATERIALS AND METHODS

Experimental location

The response of maize productivity to farmyard manure incorporation solely or combined with urea N was assessed in a field experiment during 2004. The experiment was carried out at Agricultural Research Farm of The University of Agriculture, Peshawar Pakistan. The experimental site has low N content less than 0.08 g kg^{-1}, extractable P less than 0.4 mg kg^{-1} and optimum potash greater than 100 mg kg^{-1}, having silt clay loam soil, with a mean annual rainfall of about 360 mm [4].

MATERIALS AND TREATMENTS

Seed of maize (Kissan-92 cv.) and FYM were obtained from The Agricultural Research Farm of The University of Agriculture, Peshawar Pakistan. The experiential treatments were 5, 10 and 15 tons FYM ha^{-1} incorporated alone and/or combined with 50 or 100 kg N ha^{-1}. A control plot without any fertilizer or manure was also included in each replication. A total of 10 treatments were trailed in Randomized Complete Block design having 3 replications. The plot area was 3 × 5m having 4 rows 75 cm apart with 5 meter length. The FYM was well decomposed and incorporated in the soil 40 days before sowing. Urea (46% N) was applied in a split application, half at sowing and the other half just after first irrigation. Phosphorus and potash were applied to the field at the rate 60 kg ha^{-1} each as single super phosphate (18% P_2O_5) and sulphate of potash (60% K), respectively as a basal dose. All agronomic and cultural practices including irrigation, weeding and hoeing, etc. were carried out uniformly for all the treatments in each replication.

Statistical analysis

Analysis of variance (ANOVA) was used to test the significance among the treatments and were compared using least significance test, and standard error of means [16]. The statistical software GenStat release 7.22 DE [17] was used for analysis of all data.

Observation and measurements

When almost 70% seedlings were emerged in each plot, emergence m^{-2} was carried out by counting the number of seedling emerged in two central rows and were converted into square meter accordingly. Grains per cob were recorded by counting the grains in five randomly selected cobs, after threshing manually. Ten randomly selected representative plants were used for recording plant height data. At harvest maturity plants as well as cobs in plants in two central rows were counted, and then harvested and dried to record plants ha^{-1}, cobs m^{-2}, grain yield and biological yield accordingly. After threshing, thousand grains were calculated from each plots and were weighed to record the thousand grain weight.

RESULTS AND DISCUSSION

Emergence m^{-2}

Treatments have significantly affected the emergence m^{-2} (Table 1). Control plots have lesser seedling m^{-2} compared to the manure incorporated plots (Figure 1). The probable reasons could be the soften seed bed [18] and higher moisture holding capacity [19] in manure applied plots compared to control. Within manure applied plots no significant difference were observed for emergence m^{-2}.

Table 1: Maize crop productivity in response to integrated use of FYM and urea nitrogen

Treatments		Emergence m^{-2}	Plant ha^{-1}	Cob m^{-2}	Grains cob^{-1}	1000 grain weight (g)	Plant height (cm)	Biological yield (kg ha^{-1})
FYM (tons ha^{-1})	N (kg ha^{-1})							
0	0	6	54578	6	183	257	185	9908
5	0	8	57331	7	191	280	191	11347
10	0	9	58309	8	190	259	191	12588
15	0	7	59725	7	188	297	207	13137
5	50	8	61342	8	199	288	198	15526

10	50	8	63378	8	202	337	208	15380
15	50	7	65460	7	198	286	213	15914
5	100	9	68096	9	207	322	215	17568
10	100	9	72926	9	204	302	207	17506
15	100	9	74190	9	212	342	225	17759
$LSD_{0.05}$		2	3233	2	NS	NS	NS	4091.7

Plant at harvest

Significance differences were observed for plant at harvest in response to different treatments (Table 1). Less number of plants at harvest was observed in control plots compared to fertilized plots (Figure 1). The higher mortality (15.4%) of plants in control plot over fertilized plots is associated with less availability of nutrients [20] which caused a strong competition in plants and as a law of natural survival, only some plants grew up. Among, the fertilized plots, plants at harvest was higher in plots where soil is amended with FYM as well as N compared to sole application of FYM. This difference could be related to the sufficient availability of both micro nutrients and N at early as well as latter stage of crop growth [21].

Grains per cob

Grains per cob were not significantly affected by various fertility treatments (Table 1). However, the gains per cob were greater in fertilized plots compared to control plot (Figure 1). The availability of nutrient [21] and water [19] at critical stages, i.e., grain development in manure plots could be the possible reason for improve grains per cob in manure plots compared to control plots.

Thousand grain weight

Thousand grain weights were not significantly affected by treatments (Table 1). However, the control plots produced the shrivelled grains of lower mass compared to grains developed in fertilized plots (Figure 1). Optimum utilization of nutrients and water in plots having FYM incorporated might have resulted in optimum plant growth and development as a result of deeper rooting [22] compared to control.

Plant height

No significance difference were observed for plant height due combined use of urea and FYM (Table 1), however, tallest plants were noted in fertilized plots compared to unfertilized fertilized plot (Figure 1). The taller plant in fertilized plots compared to control could be related to the higher moisture retention and its subsequent absorption by deep rooted plants [22,23] in manure plots.

Biological yield

The effect of fertility treatments was significant on biological yield of maize (Table 1). The control treatment produced significantly lower amounts of biological yield than the other N treatments (Figure 1). Among the fertilized plots, mixed application of FYM and urea N out yielded for biological yield than sole application of FYM. Generally, increasing both FYM and N had increased the biological yield of maize irrespective of the mode of application. The enhanced growth observed in the FYM treatments over the control could be associated to more favourable moisture regime in the root zone [24] and/or more efficient utilization of nutrients released from decomposition of the added FYM by the crop [19]. Increased growth rate due to higher leaf area index development in manure plots could the other reasons for higher biological yield [25].

Grain yield

Maize grain yields varied considerably among different combination of treatments (Figure 1). Fertilized Plots out yielded for grain yield in comparison to control (Figure 1).

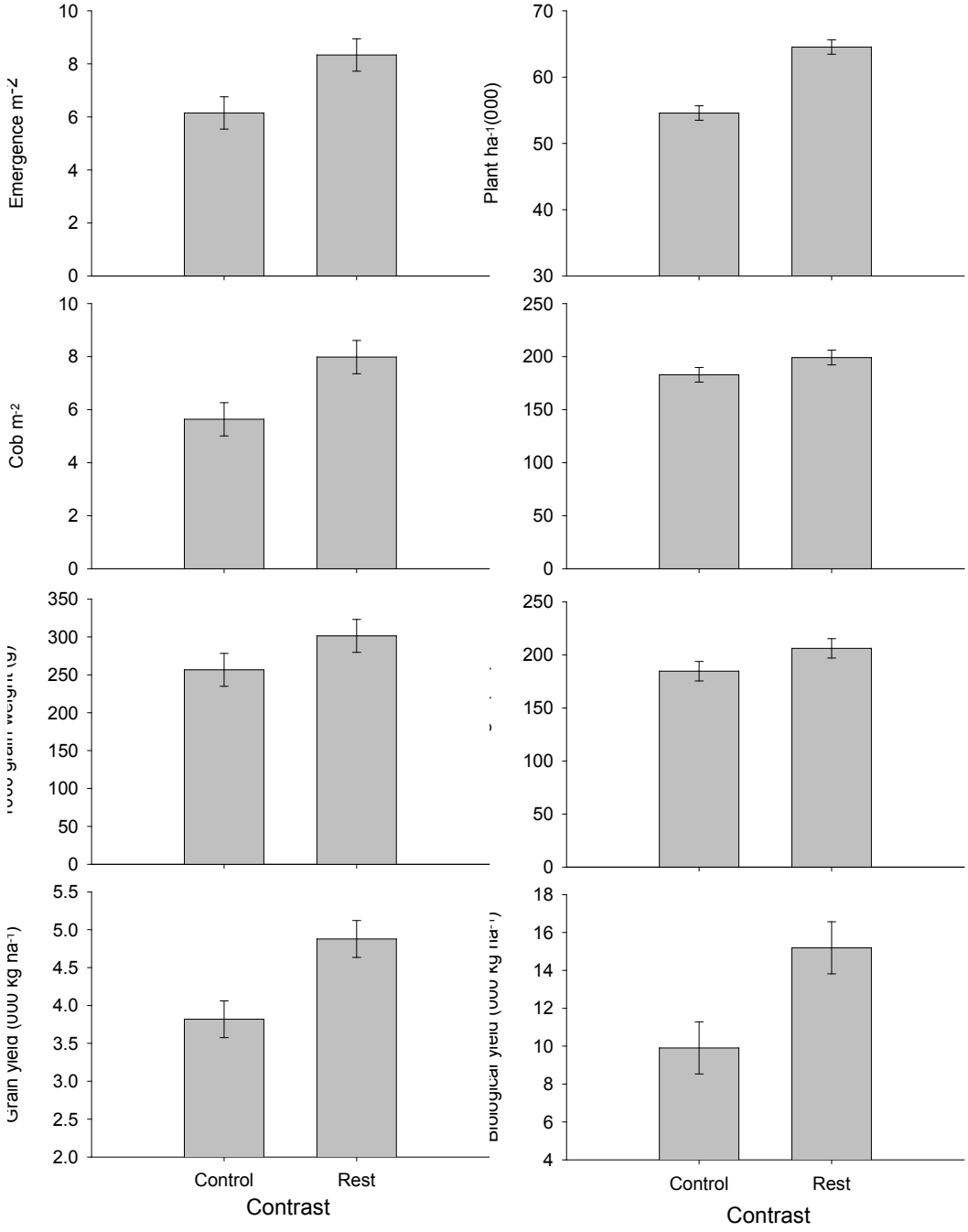

Figure 1: Comparison between control plots vs. fertilized for maize crop productivity. The vertical bars are standard errors of means

Generally, increasing the levels of N and FYM applied as combined had increased the grain yield of maize. More specifically, the higher grain yield was obtained in plots having higher level of mixed FYM and N (Figure 2). This increment due to increased levels of N could be associated with availability of optimum nutrient [19,21] or could be due to higher average leaf area index, crop growth indices, and yield attributes of cereal crops [26] in fertilized plots. The combined use of FYM and N might have increased the soil water content, improved nutrient availability, and more protection from erosion as compared with the control treatments [19,24] which could have improved growth and yield of maize.

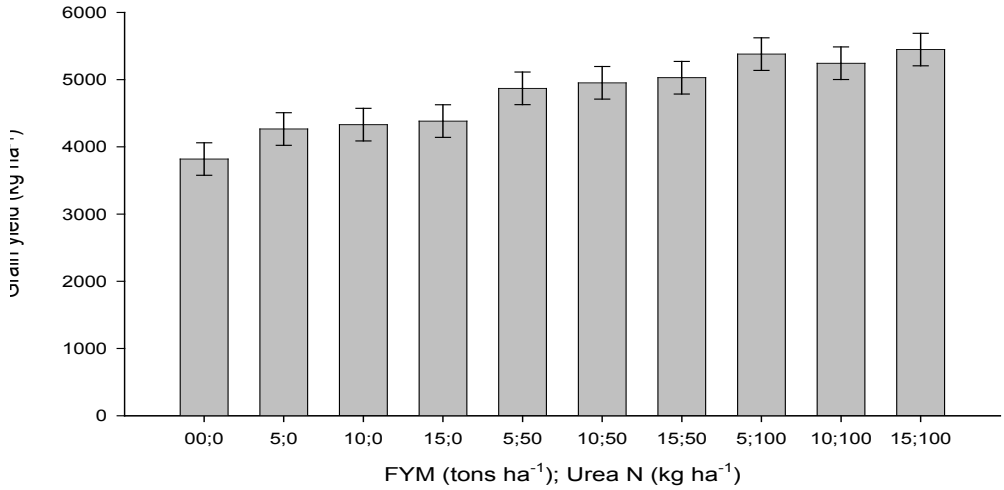

Figure 2: Grain yield (kg ha-1) as affected by integrated use of FYM and urea N. The vertical bars are standard errors of means

CONCLUSION AND RECOMMENDATION

It was concluded form the experiment that sole use of FYM has improved the crop productivity compared to control, however, the addition of urea N has further improved the maize productivity. Higher grain yield and other yield contributing factors of maize was observed when the plots are incorporated with 15 tons FYM ha^{-1} along with 100 kg N ha^{-1} and is recommended for general cultivation in the area.

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