The Journal of Animal & Plant Sciences, 22(2): 2012, Page: 334-338
ISSN: 1018-7081

EFFECTIVENESS OF TILLAGE SYSTEMS AND FARM MANURE LEVELS ON RICE PRODUCTIVITY

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ABSTRACT

Tillage management practices and farm manure application are among the most important factors affecting paddy yield. A field experiment was conducted at research area of University of Agriculture, Faisalabad, Pakistan for the purpose to investigate the effect of two tillage systems (Conventional tillage-CT ; Deep tillage-DT) under three farm manure application levels (No farm manure, 20 and 40 Mg ha^{-1}) on yield and yield components of rice crop. The experiment was carried out in randomized complete block design with split plot arrangements with three replications. All necessary parameters were observed through standard procedures. The results revealed that both tillage systems and farm manure application levels significantly affected yield and most of the yield contributing components in rice under local conditions. Among tillage methods, the maximum values of paddy yield (2911 Kg ha^{-1}) were observed in the case of deep tillage. The effect of tillage and FM significantly affected growth of rice as it increased the plant height, paddy yield, and 1000 grain weight. Maximum value of plant height (97.50 cm), number of tillers (11.80), number of grains per tiller (116), paddy yield (3003 Kg ha^{-1}), 1000 grains weight (23.00 g), were observed in case of FM application level of 40 Mg ha^{-1}. The interactive effect of tillage systems and farm manure application levels also resulted better for most of the yield contributing parameters and paddy yield (3925 Kg ha^{-1}). It is concluded that tillage methods and farm manure use are imperative for rice crop productivity and there come out substantial differences on rice yield.

Key words: Tillage systems; Farm manure levels; paddy yield; rice; Pakistan.

INTRODUCTION

Rice (*Oryza sativa* L.) is a main source of food for more than half of the world population, especially in South and Southern East Asia and Latin America. Elsewhere, it represents a high value commodity crop (Rao *et al*., 2007; Tahir *et al*., 2008). Rice is the second most important food crop after wheat in Pakistan. It accounts for 4.4% of value added in agriculture and 0.9% in GDP. It is grown on an area of 2365 (000) hectares that is about 17.9% less then the last year with average yield of 2039 Kg ha^{-1} (GOP, 2010-11). In Pakistan agriculture based economy rice plays multifarious roles. Firstly, it is second staple food and contributes more than two million tones to our national food requirement. Secondly, rice industry is an important source of employment and income for rural people. Thirdly, it contributes prominently in the country's foreign exchange.

In Pakistan there are many problems associated with soil, which affect crop growth and productivity. Some of these problems soils are poor aeration under water logged areas, crusting problems for seed germination and emergence, limited root growth due to poor soil physical condition and less extraction of water through roots from deeper depths. Resultantly, these conditions cause in decrease crop productivity. Tillage systems, farm manures and chemical fertilizers had variable effects on rice yield and growth. The farm manure improves the organic carbon by application of farm manure (Khan *et al*., 2010). The soil properties must be favorable to crop growth. Organic carbon performs additional functions of increasing soil organic matter content, and CEC, enhance biological activity, improve soil structure. (Uwah and Iwo, 2011)

Tillage is a practice which is performed to untie the soil and to bring into being a good tilth. Tillage managing practices and farm manure use are among the most important factors affecting soil physical properties and yield in rice crop. (Khan *et al*., 2010). Tillage methods affect the sustainable resources through its influence on soil properties, crop growth and the use of excessive and un-necessary tillage operations is often harmful to soil. The yield increase was correlated with increase in water contents in soil due to decrease in evaporation (Chuadhary *et al*., 1992).

Manure is excellent fertilizer containing most of the major and micro nutrients. It also adds organic matters to the soil which improves soil health. Organic matter promotes microorganism those are beneficial to plant growth because they fix certain nutrients, which lasts in soil until consumed by the plants. The principle value of manure is it's extended available of nitrogen of

particular value in the more readily leached sandy soils. Manure is also helpful in improving soil fertility in eroded areas from land leveling. On the other side heavy application of farm manure have been linked to eutrophication of surface water bodies.

In view of the above facts the investigation was carried out to determine the effect of tillage and farm manure application levels rice yield.

MATERIALS AND METHODS

a) Experiment site: Faisalabad stands in the gently sloping flat plains of northeast Punjab, between longitude 73°74 east, latitude 30°31.5 North, with an elevation of 184 meters (604 ft) above sea level. The climate of the district can see extremes, with a summer maximum temperature 50 °C (122 °F) and a winter temperature of −1 °C (30.2 °F). The mean maximum and minimum temperature in summer are 39 °C (102 °F) and 27 °C (81 °F) respectively. In winter it rises at around 21 °C (70 °F) and 6 °C (43 °F) respectively. The average yearly rainfall occurs only at about 400 mm (16 in) and is highly seasonal with approximately half of the yearly rainfall in the two months of July and August.

b) Experimental design and treatments: An experiment was conducted using randomized complete block design with split plot arrangements. Two tillage systems used were deep tillage (DT) and conventional tillage (CT), while three farm manures (FM) levels were; 0, 20 and 40 Mg ha^{-1}. Experiment was replicated thrice. The tillage systems were kept in main plots while farm manure levels in sub plots. Chisel plough was used for deep tillage while ordinary plough (tine cultivator) was used for conventional tillage. The field was ploughed thoroughly for seed bed preparation except no till plots. Rice crop was sown manually by 9 inches plant to plant and row to row spacing. Recommended level of NPK (136-67-60) were used from sources of Urea, DAP and SOP, respectively for control. While in remaining plots farm manure was applied according to nature of experiment. Whole of P and K was applied at the time of sowing and N was used in splits. One half of the nitrogen was applied after germination and other half was applied when plant attained the height of 91 cm. The field was irrigated as and when required. Plant protection measures were done through out the growing period on need. After four months the crop was harvested and data regarding plant height (cm), panicle length(cm), number of rice grains per tiller, number of tillers per plant, 1000 grains weight (g) and grain yield (Kg ha^{-1}) was recorded.

c) Characteristics of soil and Farm Manure: At harvest composite soil sample was taken from the experimental area. The soil sample was air-dried, ground, well mixed and passed through a 2 mm sieve and analyzed for physical and chemical properties. Percentage of sand, silt and clay was determined by Bouyoucos hydrometer method using one percent sodium hexametaphosphate as a dispersing agent. Textural class was determined by using the international textural triangle (Moodie *et al.*, 1959). Soil was analyzed for various chemical properties by using the methods given by Homer and Pratt (1961). The soil was analyzed for N, P and K. The soil was sandy clay loam containing 56 % sand, 19.83 % silt and 2.17 % clay. Its chemical characteristics included saturation 38 %, pH 8.4, EC 1.42 dS m^{-1}, organic matter 0.48 % (Page *et al*., 1982), total nitrogen 0.028 % (Hussain and Jabbar, 1985), available phosphorous 5.70 mg kg^{-1}, available K 124.60 mg kg^{-1} , and soil bulk density 1.45 Mg m^{-3}. The field saturated hydraulic conductivity (cm s^{-1}), bulk density (Mg m^{-2}) and soil organic matters (%) were determined. The farm manure was also analyzed for various properties and its chemical characteristics included Nitrogen (N) 2.37ppm, Phosphorus (P) 393.70ppm, Potassium (K) 2805.00ppm and Organic Carbon 16.22ppm.

d) Data analysis: The data collected for various variables was subjected to statistical analysis using the analysis of variance technique by using "MSTAT-C" (Anonymous, 1986) where as the means were compared through LSD test at 0.05 p (Steel *et al*., 1997)

RESULTS AND DISCUSSION

Effect of tillage and farm manure on plant height (cm) at crop harvest: Plant height is an important component of plant growth and yield. Both the tillage systems and farm manure levels affect plant height significantly as individual factor and in combination. As regard tillage systems, more plant height (103.90 cm) were observed in case of deep tillage compared to conventional tillage (67.40 cm). It showed 54% increase in plant height over conventional tillage might be due to deep tillage that resulted in break down of hardpan which facilitates root proliferation; more nutrients were available to plants. The results are in conformity with Panthak *et al*., 2004 and Tomar *et al*., 2005. They reported maximum plant height under tillage and puddle conditions. Regarding farm manure, maximum plant height was observed at farm manure level of 40 Mg ha^{-1} as compare to other treatments. Mean increase in plant height was 33% in case of 40 Mg ha^{-1} farm manure level and 14% in case of 20 Mg ha^{-1} as compared to control where no FM was applied. These results are might be due to the role of organic carbon in case of maximum level of FM. Use of organic amendment and farm manure is a cumulative manner can meet the nutrient requirement and enhance soil organic carbon, available P, and microbial population/enzymatic activity of soil making it sustainable for crop production.

As regard the interactive effect of both tillage and farm manure application, maximum mean value of plant height (119.30 cm) was observed in treatment combination of deep tillage and 40 Mg ha^{-1} level of FM followed by 104 cm in case of deep tillage and 20 Mg ha^{-1}. It showed 35 and 19% increase in plant height as compare to conventional tillage with no FM. Bhantager *et al*. (1986) also reported that FM incorporated at the soil surface, increased plant height because manure application improves soil physical properties and provides the necessary plant nutrients.

a) **Effect of tillage and farm manure on panicle length (cm) of rice:** The data regarding effect of tillage systems and farm manure is depicted in Table. 1. Analysis of variance indicates significant effect on panicle length. Regarding farm manure, it showed significant effect on panicle length as comparatively more length was observed in FM treatments. The highest value (28.78 cm) of panicle length was observed in case of farm manure level of 40 Mg ha^{-1} followed by (27.37 cm) in FM level 20 Mg ha^{-1} and the lowest (25.37 cm) was observed in case of control where no FM was applied. Mean increase in panicle length of crop was 13% in case of maximum level of application of FM and 5% in case of 20 Mg ha^{-1} FM level over control. These results are supported by Tomer *et al*. (2005) who reported that tillage systems and manure significantly increased panicle length rice in puddled soil than others, because manure application improves soil physical properties and provides the necessary plant nutrients. The interactive effect between tillage methods and farm manure applications was non significant.

b) **Effect of tillage and farm manure on number of tillers per plant of rice:** The results are depicted in Table.1 indicated that farm manure had significant effect on number of tillers of rice. The highest number of tillers (11.80) of rice was observed from application of farm manure level 40 Mg ha^{-1} followed by FM level 20 Mg ha^{-1} (11.15) and the lowest (9.45) in case of control. Mean increase in number of tillers was 25% and 6% in case of FM level, 40 and 20 Mg ha^{-1} over control, respectively. Sharma and Mittra, 1990; Tomer *et al*., 2005) reported that organic mannuring of rice crop with locally available materials (wheat straw, paddy straw, FM, azolla, sun hemp) was found to increased dry biomass yield in rice. The interactive effect between tillage systems and farm manure application is non-significant.

c) **Effect of tillage and farm manure on number of rice grains per tiller:** Data regarding effect of tillage and farm manure on number of rice grains per tillers is presented in Table 1. It showed that farm manure application and tillage methods had a significant effect on number of rice grains per tiller.

Regarding tillage systems, maximum number of rice grains per tiller (118) was observed in deep tillage as compare to conventional tillage (114). Increase in number of grains per tiller was 39% in DT compared to conventional tillage (CT). These results are in conformity with those of Tomer *et al*. 2005, who reported taller plants and more number of grains per tiller in case of deep tillage. FM application showed highest number of grains (118) per tiller in case of 40 Mg ha^{-1} application level of FM followed by 20 Mg ha^{-1} level of FM (109) over lowest (108) in case of control.

The interactive effect of both treatments depicted (Table 1) that maximum mean value of number of rice grains per tillers (126.8) was observed in treatment combination of application of FM at level 40 Mg ha^{-1} and DT followed by 118 in case of DT + FM level of 20 Mg ha^{-1}. These results are in agreement with those of Singh *et al*., 2007 who reported that four organic treatments such as blue green Algae 15 Kg ha^{-1}, Azola 1.0 Mg ha^{-1}, Vermicompost and farm yard manure 5.0 Mg ha^{-1} increased number of grains per tiller in rice because application improves soil physical properties and provides the necessary plant nutrients.

d) **Effect of tillage and farm manure on 1000 grains weight (g) of rice:** The effect of tillage and farm manure on 1000 grains weight of rice is presented in Table.1. The data indicated that farm manure and tillage systems had a significant effect on 1000 grains weight of rice.

Regarding tillage systems the highest mean 1000 grains weight (21.90 g) was observed in DT as compare to CT (20.40 g). Mean increase in 1000 grain weight of rice was 84 % in DT as compared to control. Similarly, farm manure application has its positive effect on 1000 grains weight of rice. The highest 1000 grains weight (23.00 g) was observed in plots where FM was applied at the level of 40 Kg ha^{-1} followed by 20 Mg ha^{-1} (19.90 g) and least in case of control (17.60 g) Mean increase in 1000 grains weight of rice crop was 29% in case of application of 40 Mg ha^{-1} FM and 15% in 20 Mg ha^{-1} as compared to control.

The interactive effect of tillage and farm manure showed also significant differences. Maximum mean value of 1000 grains weight of rice (24.90 g) in treatment combination of DT + FM level of 40 Mg ha^{-1} followed by 21.50 g from treatment combination of DT + 20 Mg ha^{-1} FM level was recorded. The least value of 1000 grains weight was observed as 17.60 g in case of CT + Control. Rehman *et al*., 2004 indicated that optimum number of four passes and tillage systems for better productivity of rice resulted in maximum 1000 grains weight.

e) **Effect of tillage and farm manure on paddy yield (Kg ha^{-1}) at harvest:** Total biomass (paddy yield) correlates with grain and straw yield. The data presented in Table 1, illustrated that application of different doses

of farm manure and tillage systems had a pronounced impact on yield of rice.

Tillage systems significantly affected paddy yield. Deep tilled soils had taller plants with high yield rice than conventional tilled soils. The highest paddy yield (2911 Kg ha^{-1}) was observed in DT compared to conventional tillage (1616 Kg ha^{-1}) and it showed that increase in paddy yield at harvest of crop was 80% in deep tillage over conventional tillage (CT). Tomer *et al*. (2005) performed experiment on rice and concluded that tillage systems and moisture regimes had significant residual effect on rice yield under mould board ploughing in comparison with tillage systems.

Farm manure had also significant effect on paddy yield of rice. The highest paddy yield was (3003 Kg ha^{-1}) observed in plots where FM was applied at level of 40 Mg ha^{-1}, followed by FM level of 20 Mg ha^{-1} (2376 Kg ha^{-1}) against the lowest in case of control (1410 Kg ha^{-1}). Mean increase in paddy yield of crop was 113% and 26% in case of FM application levels of 40 and 20 Mg ha^{-1}, respectively compared to control, where no farm manure was applied.

As regards the interactive effect of tillage and farm manure, the maximum mean value of paddy rice (3925 Kg ha^{-1}) was observed in case DT along with FM application level of 40 Mg ha^{-1} followed by application of FM 20 Mg ha^{-1} in DT (3199 Kg ha^{-1}). These results are in conformity with those of Rasool *et al*., (2007) who concluded that application of manure and an inorganic fertilizer in rice-wheat cropping system, increased paddy yield in rice because manure application improves soil health and provides plant nutrients.

Table 1. Effect of Tillage and farm manure application on yield and yield contributing factor in rice

Parameters	*Plant Height (cm)*	*Panicle Length(cm)*	*Number of tillers per plant*	*Rice grains per tiller*	*1000 grains weight (g)*	*Paddy yield (Kg ha^{-1})*
Tillage Systems (TS)						
DT	103.89a	27.43^{NS*}	11.07^{NS}	118.08a	21.90a	2911.00a
CT	67.33b	26.93^{NS}	10.52^{NS}	113.60b	20.20b	1616.00b
Farm manures (FM)						
Control	73.50c	25.37b	9.45b	108.50b	18.50c	1410.00c
FM1	85.83b	27.37a	11.15a	109.50b	20.80b	2376.00b
FM2	97.50a	28.78a	11.80a	116.10a	23.90a	3003.00a
Interaction (TM x FM)						
DT x Control	88.00c	25.80^{NS}	9.58^{NS}	109.30d	19.40de	1606.00d
DT x FM1	104.30b	27.30^{NS}	11.37^{NS}	118.10b	21.50bc	3199.00b
DT x FM2	119.30a	29.17^{NS}	11.27^{NS}	126.80a	24.90a	3925.00a
CT x Control	59.00f	24.93^{NS}	9.33^{NS}	107.70d	17.60e	1214.00e
CT x FM1	67.33e	27.43^{NS}	10.92^{NS}	114.10c	19.90cd	1553.00d
CT x FM2	75.67d	28.40^{NS}	11.33^{NS}	119.00b	23.00ab	2081.00c

The means in columns bearing same letters do not differ significantly ($p<0.05$), *NS (Non Significant).

Conclusion: It is concluded that tillage methods and farm manure use are imperative for rice crop productivity and there come out substantial differences on rice yield.

Acknowledgement: We deeply appreciate the role of women in agriculture (79.4% of rural women are engaged in agriculture as against 60.8% of rural men). Women extensively participate in the production of major crops; the intensity of their labour varies by crop and specific crop management tasks. Women's heavy work load - with dual responsibility for farm and household production is increasing as agriculture is feminized.

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