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EFFECT OF VARIOUS TILLAGE METHODS AND NITROGEN MANAGEMENT ON WEEDS AND MAIZE PERFORMANCE

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ABSTRACT

Weeds are the major source of yield loss in maize crop. To investigate the effect of different tillage practices and nitrogen (N) management techniques, an experiment was conducted at Agricultural Research Farm, Khyber Pakhtunkhwa Agricultural University Peshawar, Pakistan during summer 2010. The experiment was laid out in randomized complete block design with split plot arrangement having three replications. The experiment consisted of 10 fertilizer treatments i.e. control, sole nitrogen, farm yard manure (FYM), poultry manure (PM), 75% N (mineral) + 25% FYM, 50% mineral N + 50% FYM, 25 % mineral N + 75% FYM, 75% N + 25% PM, 50% mineral N + 50% PM, and 25% mineral N + 75% PM; and three tillage practices viz. reduced tillage (RT), conventional tillage (CT) and deep tillage (DT). Maize variety "Azam" was sown with a plot size of 4.5m x 5m for each experimental unit. Tillage practices were kept in main plots while N treatments were allotted to the sub plots. Tillage practices and N management significantly affected weed density, fresh and dry weed biomass and yield components of maize. Weed density and fresh and dry weed biomass were significantly higher for RT followed by CT and DT. Application of half mineral N and half PM produced the highest thousand grain weight, grain yield and biological yield of maize. In contrary, half mineral N + half PM resulted in lowest weed density, fresh weed biomass and dry weed biomass. Tillage also influenced yield and yield components of maize as highest thousand grain weight, grain yield and biological yield was produced by CT. It was concluded that management of organic and inorganic N application and CT has a beneficial effect on weed control and maize yield.

Key words: Maize, nitrogen, tillage, weeds, yield, *Zea mays* L.

INTRODUCTION

Maize (*Zea mays* L.) is a multipurpose crop that provides food for human and feed for animals especially poultry and livestock. It is a rich source of raw material for the industries where it is being extensively used for the preparation of dextrose, syrup and flakes

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(Khaliq *et al*., 2004). Although maize producers are facing so many economic problems, one of the major concerns is inadequate weed control. Wilson and Foy (1990) concluded that, several weeds species could not be effectively controlled although many effective herbicides have been developed in last few years. Weeds resulted up to 40% decrease in maize yield and net income of small land holding farmers in Nigeria (Zuofa and Tariah, 1992). The reduction in crop yield depends upon weed species and density (Chikoye *et al*., 2004). Maize is most sensitive to weed competition during the first 3-4 weeks (Sandhu and Gill, 1973).

The composition of weed communities is greatly affected by tillage systems. Weed control is a problem in reduced tillage (RT) which often favors annual grasses and discourages annual dicotyledonous species (Chikoye *et al*., 2004). Tillage is a set of operations performed on the soil to prepare a seedbed, control weeds and improve soil physical conditions for enhancing the establishment, growth and yield of crops, as well as conserving soil moisture (Elliot *et* al., 1993). Tillage as a mean of weed control is primarily achieved by burial of small annual weeds with soil thrown over them (Khajanji et al., 2002).

In general, any good tillage system should provide good soil tilth, improve soil water infiltration and retention, reduce weed competition, minimize soil erosion, control infestation of pests, encourage biological activities of soil micro-organisms and recycle soil organic matter through residue management. In many ecological zones and on different soil types, crop response to tillage and indeed the economic viability of tillage and role of tillage systems in weeds control are still subjects of investigation (Hussein, 1997).

The role of organic manure in the maintenance of soil fertility has long been recognized in its slow release of balanced nutrients, improvement of soil physical properties and the amelioration of acidifying effect of inorganic fertilizer under continuous cultivation (Singh *et al.*, 1980; Agboola, 1981). However, information on the particular combination of tillage and manure in specific environments that will result in optimal yield of crops is still limited. Weed density, type of the weeds, their persistence and crop management practices determine the magnitude of yield losses. Organic farming systems rely on a limited spectrum of means for controlling an established weed community (Khaliq *et al.*, 2004).

This study was designed to investigate the main effects of three tillage systems and two types of organic manure applied at the different rates in combination with mineral nitrogen and tillage x fertilizer interaction on weed control and yield of maize.

MATERIALS AND METHODS

To investigate the effect of different tillage systems (reduce, conventional and deep tillage) in different combination of organic and inorganic source of nitrogen, an experiment was conducted at New Developmental Farm of Agricultural University Peshawar during summer 2010. The experimental treatments were consisted of three tillages systems (CT, RT and DT) and 10 fertilizer treatments combinations i.e. control, nitrogen alone, FYM alone, poultry manure alone, urea 25% + 25% FYM, 50% N + 50% FYM, 75% N + 25% FYM, 25% PM + 75% N, 50% PM + 50% N and 75% PM + 25% N. The experiment was laid out in randomized complete block design with split plot arrangement having three replications. Maize variety "Azam" was sown on 25th June, 2010 with row to row and plant to plant distance of 75 and 25 cm, respectively.

Tillage practices were allotted to main plot and N fertilizer treatments were kept in sub plots. All organic manures were applied one month before sowing. Urea was used as a source of mineral N while FYM and PM were used as organic manure. Deep tillage practices were carried out by chisel plough that tilled the soil up to 45 cm followed by a cultivator. Cultivator was used for CT, which tilled the soil up to 30 cm. In both DT and CT, the soil was ploughed two times horizontally as well as vertically followed by planking to break the clods and level the field. Reduce tillage practice was carried out by rotavator to bury only the FYM/PM up to the depth of 4-6 cm. The field was irrigated as and when needed. All other agronomic practices were kept constant for all the experimental units. Data were recorded on weed density, fresh weed biomass, dry weed biomass, grain yield, thousand grain weight and biological yield. Chemical analysis of organic manures used in experiment is presented in Table-1.

Table-1. Chemical composition of Farm Yard Manure and Poultry Manure used in the experiment.

S.No	Organic manure	Nitrogen %	Phosphorus %	Potash or Potassium %
01	Farm Yard Manure (FYM)	0.87	0.37	0.5
02	Poultry Manure (PM)	2.31	2.06	1.67

Weed density was recorded at 40 days after sowing (DAS) from randomly selected three sites one meter long from each experimental unit and was averaged. Fresh and oven dry biomass of the samples were also recorded. For collecting data on growth and yield parameters of the crop standard procedures were followed. The grain yield was determined by harvesting five central rows in each subplot. The ears from harvested plants were detached, threshed, weighed and was converted to kg ha^{-1}. Thousand grains were counted at random from each sub plot of each treatment and weighed.

Data collected were analyzed statistically according to the procedure relevant to RCB design. Upon significant F-Test, least significance difference (LSD) test was used for mean comparison to identify the significant components of the treatment means (Jan *et al*., 2009).

RESULTS AND DISCUSSION

Weed density (m^{-2})

The effect of different tillage systems and nitrogen source management on weed density was significant while interaction between them was not significant (Table-2). Weed density was higher in reduce tillage plots (149 m^{-2}) when compared to deep (121 m^{-2}) and conventional tillage (93 m^{-2}). These results are in line with Cardina *et al*. (1991) who reported that an increase in soil disturbance results in decreased number and diversity of weeds species. Similarly, Kang *et al*. (1980) also reported an increase in weed density in no-till system after one year. Higher number of weeds (154 m^{-2}) were recorded in plots fertilized with organic manures (FYM) followed by PM (129m) alone which was statistically at par with sole mineral N application. Lower weeds density (97 m^{-2}) was obtained from control plots. Possible reason for higher weeds density in organic manure plots may be the manures contain different weeds seeds and thus increased weed seed bank in field. Similar results were reported by Hammad *et al*. (2010) who stated that application of organic manures resulted in higher weeds biomass and weeds density.

Fresh and dry weed biomass (g)

Data regarding fresh and dry weed biomass are reported in Table-2. Analysis of the data showed that different tillage systems and nitrogen source management significantly influenced fresh and dry weed biomass. However, interaction between tillage and nitrogen management was not significant. Higher fresh (314 g) and dry weed biomass (123 g) was recorded in RT followed by DT (260 g fresh biomass and 92 g dry biomass), whereas lower fresh and dry weed biomass was recorded in conventional tillage plots. Among nitrogen source management treatments, higher fresh and dry weed biomass (302g and 106g) was recorded in plots where sole N was applied followed by integrated N application. Lower fresh weed biomass (236 g) was recorded from control plots and lower weeds dry biomass was recorded from plots where PM and N was used in combination. These results indicated that weed biomass decreased with imposing tillage.

Table-2. Weed density, fresh and dry biomass as affected by various tillage practices and N management.

Tillage Practices	Weed density m^{-2}	Fresh weed biomass (g)	Dry weed biomass (g)
Reduce Tillage	149 a	314 a	123 a
Conventional Tillage	93 c	242 b	76 c
Deep Tillage	121 b	260 b	92 b
LSD	5.3	19.01	8.3
Nitrogen Management			
Control	97 e	236.22 d	88.81 ef
Nitrogen alone	126 bc	302.67 a	106.56 a
FYM Alone	154 a	293.78 ab	85.00 f
Pm Alone	129 bc	276.89 bc	103.59 abc
25 % N 75 % FYM	110 d	268.67 c	95.22 de
50 % N 50 % FYM	128 bc	238.00 d	97.96 bcd
75 % N + 25 % FYM	116 cd	300.00 a	105.67 ab
25 % N 75 % PM	122 bcd	274.33 bc	97.11 cde
50 % N 50 %PM	110 d	234.67 d	83.89 f
75 % N + 25 % PM	116 cd	296.00 ab	104.33 abc
LSD	14.7	30.41	10.01
Interaction			
N x T	NS	NS	NS

Means followed by different letters in each category are different at 5% level of probability. NS = non significant.

Possible reason for this could be that tillage destroyed the existing weeds seed bank and prevented the germination of the small seeded weeds by burying them deep. Therefore, the intensity of weeds was less in the tilled plots compared to no-till. These results for the tillage effects are in line with the findings of Tangadulratana (1985) and Arif *et al*. (2007) that weeds fresh and dry biomass tended to be less when tillage was imposed and deep tillage resulted in lower weeds density as compare to reduce tillage. Also, Elliot *et al*. (1993) reported that increasing the number of plowing and harrowing, weed biomass and time required for weeding were reduced whereas grassy weeds were more under zero tillage compared to conventional tillage. Kamau *et al*. (1999) reported that tillage reduced fresh weed biomass.

Thousand grain weight

Thousand grain weight was significantly affected by tillage practices and various organic and inorganic N treatments. Interaction between T and N was not significant. The RT plots had lighter grains (232.6 g) as compared to DT (252.5) and CT (254.5) (Table-3). Heavier grains were produced by CT and DT because it cuts the soil deeper and hence more water can be retained, roots can grow deeper in search of moisture and nutrients. These results are in line with

(Lemcoff and Loomis 1994) also poor root growth might have affected nutrients uptake during grain maturation and resulted in under weight grain formation. These results for tillage effect are in line with those of Kang *et al*. (1980) that reduce tillage in maize gave less grain weight than that of conventional tillage. Maize higher grain weight (262.6) was obtained from plots where PM and urea was applied in combination (50%PM + 50%N) which was at par with the application of 75% N + 25% PM and half FYM + Half Urea. Control plots resulted in lighter grain weight (232.9 g). The lower N level in the soil resulted in lower yield due to less available N for the optimum plant growth (Ogola *et al*., 2002).The incorporation of organic manure in the soil have thought to reduce the evaporation demand, thus have adequate water for plant root growth, or perhaps due to the softness of soil caused by manure in which the roots may expand rapidly enough into wet soil to meet plant water requirements (Jama and Ottman, 1993).These results are also in line with Patil *et al*. (2006) who concluded that the potential of FYM or other organic manure improve when used with mineral fertilizer. Our results are also confirmed by the findings of Yang *et al*. (2007) and Deksissa *et al*. (2008).

Grain yield (kg ha^{-1})

Grain yield is a function among various yield components that were significantly affected by various N source managements and different tillage practices. Data regarding grain yield are presented in Table-3. Grain yield was significantly affected by nitrogen source management (mineral and organic N), their combination and tillage practices while interaction between N and T was not significant. Higher grain yield (4306 kg ha^{-1}) was produced from the plots which received 50 % N + 50 % PM, which was at par with (50% FYM + 50% N) it was followed by (75 % N + 25 % PM). Lower grain yield (2489 kg ha^{-1}) was recorded in control plots. Deep and conventional tillage produced higher grain yield (3505 & 3405 kg ha^{-1}, respectively) as compared to reduced tillage (3219 kg ha^{-1}). These results are in accordance with Kang *et al*. (1980) who suggested that modifying the CT with RT system did not decrease grain yield. Timely availability of N could be insured and corn productivity can be positively increased by combined use of organic and inorganic source of N. These results are in line with Ogola *et al*. (2002) and Kahjanji *et al*. (2002) who found that No tillage or reduce tillage results in 35% reduction in corn yield as compared with conventional tillage

Biological Yield (kg ha^{-1})

Biological yield is the result of nutrient uptake. Data presented in Table-3 showed that biological yield was significantly affected by various N sources and tillage practices. There is no significant interaction between tillage and nitrogen management. Higher biological yield (16502.4Kg ha^{-1}) was recorded in plots fertilized with integrated N management i.e., 50 % N + 50 % PM which was at par with application of half FYM + half N followed by sole mineral N used (13646.9 kg ha^{-1}) which was at par with (75 % N + 25 % PM) .The lower biological yield was obtained from control plots. The increase in biological yield reflects the better growth and development of the plants due to balanced and more availability of nutrients throughout the growing period. Patil *et al*. (2006) reported that integrated use of FYM or PM and low rates of NP fertilizers are better than the application of either NP fertilizers or organic manure alone. These results are in consonance with the results of Khan *et al*. (2008). Higher biological yield was recorded from plots where conventional tillage was practiced; while lower biological yield was recorded from reduce tillage. Our results are in line with Govaerts *et al*. (2005) who reported that tillage method significantly affected all the traits measured in corn. Corn stover yields can be increased by conventional tillage or alternate tillage as compare to no or reduce tillage (Soon *et al*., 2005).

Table-3. Thousand grain weight, grain yield and biological yield as influenced by tillage practices and N management.

Tillage Practices	Thousand Grain weight (g)	Grain yield (Kg ha^{-1})	Biological Yield (Kg ha^{-1})
Reduce Tillage	232.6 b	3219.0 b	11889.5 b
Conventional Tillage	254.5 a	3404.5 a	13020.2 a
Deep Tillage	252.6 a	3504.5 a	12691.8 ab
LSD	15.4	136.5	808.9
Nitrogen Management			
Control	232.9 d	2489.0 f	11050.7 c
Nitrogen alone	245.4 bcd	3742.4 c	13646.9 b
FYM Alone	234.7 cd	2800.0 e	10735.5 c
Pm Alone	235.4 cd	2664.7 ef	9688.9 c
25 % N 75 % FYM	241.9 cd	3140.3 d	10953.9 c
50 % N 50 % FYM	248.6 abc	4178.9 ab	16139.9 a
75 % N + 25 % FYM	256.7 abc	3866.7 c	13147.4 b
25 % N 75 % PM	248.3 abc	2611.1 ef	9572.1 c
50 % N 50 %PM	262.6 a	4306.1 a	16502.4 a
75 % N + 25 % PM	258.9 ab	3960.7 bc	13900.3 b
LSD	18.01	345	2069.7
Interaction			
N x T	NS	NS	NS

Means followed by different letters in each category are different at 5% level of probability. NS = non significant.

CONCLUSION

It is concluded that conventional and deep tillage resulted in lower weeds density, fresh and dry weight and produced higher yield and yield components than reduced tillage, however keeping in view the income of farmer, conventional tillage should be adopted for higher maize yield due to less fuel consumption. Organic manure (poultry and farm yard manure) along with 50% nitrogen from urea resulted in higher yield and yield components than sole application of organic and mineral nitrogen.

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