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EFFECT OF TILLAGE ON WEEDS AND ECONOMICS OF FODDER MAIZE PRODUCTION

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ABSTRACT

An experiment was conducted at Agricultural Research Farm, NWFP Agricultural University Peshawar during spring 2007. The experiment was laid out in randomized complete block design having four replications. The tillage systems consisted of no-till (NT), conventional tillage (CT) and deep tillage (DT). Maize type sweet corn (Swat local) was sown on April 23, 2007. The net plot size of 30 x 20 m^2 was used. The crop was sown as broadcast with seed rate of 60 kg ha^{-1}. Phosphorus and nitrogen were applied at the rate of 90 and 120 kg ha^{-1}, respectively. Weed density and diversity were significantly higher for NT followed by RT and DT. Higher fresh and dry weights of weeds were also noted in NT followed by RT and DT. RT resulted in higher fresh fodder yield followed by DT and NT. Similarly, RT resulted in higher gross income and gross margin. However, comparison showed that NT with less fuel consumption could be a viable economical alternative when the efficiency coefficients are taken into account which was 1:4 for NT.

Key words: Spring maize, tillage, weeds, fodder

INTRODUCTION

Maize (*Zea mays* L.) is the most important cereal and fodder crop of NWFP and Pakistan. It is a dominant crop in the farming system because it is a staple food crop for most of the rural population as well as fodder for their animals. Maize is cultivated both in spring and summer season in NWFP as a dual purpose crop. Staggered planting from February to September helps cope with the fodder scarcity problems faced in May-June and October-November. Its nutritious fodder is relished by all livestock, especially milch animals. The green fodder of maize contains 1.56% protein, 0.30% fat, and

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5.27% fibre. It is a cash crop for growers, as around cities it is widely grown for sale as green fodder (Chaudhry, 1994).

There are many factors responsible for low fodder and grain yields of maize. Two of the major causes of low yield are the type of tillage and the weeds infestation, which can cause yield reduction up to 30% (Guncan, 1976).

Tillage is considered the most effective farm activity for the purpose of developing a desired soil structure. It improves the physical conditions of soil and favors the rooting characteristics of plants, which lead to an enhanced nutrient uptake and better yield of crops (Arif *et al*., 2007). Tillage constitutes a fundamental component in the weed management strategies. It not only kills weeds, but also disturbs the soil (Mohler and Galford, 1997). Although herbicides have improved the capability of farmers and helped to control weed but it is a potential ecological hazard (Felton and McCloy, 1992).

Weed control is a limiting factor in crop production (Buhler, 1992). Weeds are probably the most ever-present class of crop pests and on the odd occasion cause massive crop failures over vast areas. They reduce the crop yield and deteriorate the quality of produce and hence reduce the market value of the turn out (Arif *et al*., 2006). They use the soil fertility, available moisture and nutrients compete for space and light with crop plants, which result in yield reduction (Khan *et al*., 2004). If left uncontrolled, the weeds in many fields are capable of reducing yields by more than 80% (Karlen *et al*., 2002).

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 (Froud-Williams *et al*., 1981; Gill and Arshad, 1995). However, generalizations are limited, because the effect of tillage on annual weeds is species-specific (Buhler, 1992), and the same species may respond differently when soil properties and other site characteristics vary. Derksen *et al*. (1993) reported that weed communities were greatly affected by location and year as compared to tillage systems. Increased soil disturbance decreased the number of weed species and species diversity in maize cropping (Cardina *et al*., 1991). The relative contributions to the size and diversity of weed flora were greater by common species under conventional tillage (CT) and by rare species in less intensive tillage systems in spring crops (Gill and Arshad, 1995).

The disadvantages of RT are infestations by several annual and perennial species and rapid increase of the seed bank near the soil surface. Hence, occasional or rotational use of RT may be a practical way to adopt RT into CT systems. Changes between tillage practices, from CT to RT and vice versa, were effective in suppressing weed growth and preventing seed accumulation (Nakamoto *et al*., 2006).

The objectives of this study were to asses the financial feasibility of using various tillage systems and their effect on weed density and fodder yield of maize.

MATERIALS AND METHODS

An experiment was conducted at Agricultural Research Farm, NWFP Agricultural University Peshawar during spring 2007. The experiment was laid out in randomized complete block design having four replications. The tillage systems consisted of no-till (NT), conventional tillage (CT) and deep tillage (DT). In no-till, the soil was not tilled but the land was leveled with the help of leveler. In reduced tillage, the field was ploughed with cultivator to the depth of about 30 cm while in deep tillage the field was ploughed with chisel plough to a depth of about 65 to 70 cm. Maize type sweet corn (yellow) was sown on April 23, 2007. The net plot size of 30 m by 20 m was used. Crop was sown as broad cast at the seed rate of 60 kg ha^{-1}. Phosphorus and nitrogen were applied at the rate of 90 and 120 kg ha^{-1}, respectively. Urea and single super phosphate were used as sources of N and P, respectively. All phosphorus and one third of nitrogen were applied at the time of sowing while remaining nitrogen was applied in two split applications i.e. at first irrigation and at 6-7 leaf stage of crop. First irrigation was done after two weeks of sowing, and remaining irrigations were applied as and when needed. All other agronomic practices were kept uniform for all treatments. Data were recorded on weed density and diversity, fresh and dry weight of weeds and fresh fodder yield. For economic analysis, gross income, variable cost, gross margin and efficiency coefficient (Output: input) were determined according to Ozpinar (2006).

Statistical analysis

The data recorded were analyzed statistically using analysis of variance techniques appropriate for randomized complete block design. Means were compared using LSD test at 0.05 level of probability, when the F-values were significant (Steel and Torrie, 1980).

RESULTS AND DISCUSSION

Weed density (m^{-2})

The effect of tillage systems on weed density was significant. Weed density was greater in no-till (NT) (300 m^{-2}) when compared to reduced tillage (RT) (211 m^{-2}) and deep tillage (DT) (206 m^{-2}) (Table-1). These results do agree with Cardina *et al*. (1991) who reported that an increased soil disturbance results in decreased number and diversity of weeds species. Similarly, Taesdale *et al*. (1991) also reported an increase in weed density in no-till system after one year. The major weeds noted were *Cyperus rotundus*, *Cynodon dactylon*, *Chenopodium album*, *Echinochloa crus-galli* and *Cucumis prophetarum* and were sorted into groups according to their life cycle (Table-1). Annual weeds did not show dependable response to tillage system except *E. colonum* which decreased with increase in tillage intensity. These results agree with Bostrom and Fogelfors (1999) who reported that soil disturbance has limited influence on the summer annual weeds. Among the perennial weeds, the density of *C. dactylon* decreased with increase in tillage intensity while *C. rotundus* showed inconsistent response to tillage intensity. Many researchers stated that reduced tillage system increases perennial weed densities and diversity (Pollard and Cussans, 1976; Gill and Arshad, 1995; Feldman *et al*., 1988).

Fresh and Dry weight of weeds (kg m^{-2})

Perusal of the data indicated that tillage significantly affected fresh and dry weight of weeds (Table-2). Higher fresh and dry weight of weeds were noted in NT (1.37 and 0.277 kg m^{-2}, respectively) followed by RT and DT which were statistically at the same level. Higher fresh and dry weight of weeds in NT may be due to higher emergence of weeds and also poor crop stand of maize which shifted the competition in favor of weeds and thus resulted in prolific weeds growth. Arif *et al*. (2007) also reported that weeds control is a great problem in RT. These findings are in also corroboration with Bhagat *et al*. (1999) who observed that an increase in tillage intensity reduced weed growth.

Fodder yield (tons ha^{-1})

Analysis of data revealed that tillage systems significantly affected fodder yield of maize. RT produced maximum fresh fodder yield (131 tons ha^{-1}) followed by DT (120 tons ha^{-1}) which were statistically at par with each other (Fig.-1). Minimum fodder yield (54 t ha^{-1}) was recorded for NT. The improved fodder yield may be ascribed to more emergence and better weed control in RT and DT systems. The low fodder yield in NT may be due to slower early growth with NT management and reduced early nutrients uptake and growth (Al Darby and Lowery, 1987; Swan *et al*., 1987; Kaspar *et al*., 1990). Delayed early growth of maize under conservation tillage compared to conventional tillage may be caused by higher mechanical impedance (Hughes *et al*., 1992). The results are in line with Lichet and Al-Kaisi (2005) who attributed better biomass yield with chisel plough and strip tillage systems to better soil conditions early in the season and consequently improved early corn growth compared with no-tillage system.

Economic analysis

The variable cost shown in Table-3 is the cost of different tillage operations because all plots received the same amount of seed, fertilizer, and labour etc for cultivation practices during the growing period and were only different in the number of tillage operations in terms of fuel and time. Different tillage systems fetched significantly different gross income. RT resulted in higher gross income as compared to NT and DT. Likewise, RT gave the highest gross margin followed by DT and NT. The gross margin for RT was the highest due to the highest gross income compared with other tillage systems. But costs particularly in seedbed preparation were the lowest in NT compared with RT or DT. The lowest total cost in NT was due to the lowest cost of seedbed preparation per hectare. Hence this comparison shows that NT with less fuel consumption could be a viable economical alternative when the efficiency coefficients are taken into account which is higher in NT with 1:4. Similar results were reported by Ozpinar (2006) who also noted higher gross income and gross margin for RT.

Similarly, Abu-Hamdeh (2003) pointed out that net economic return was lower in mouldboard plough tillage than other reduced tillage systems. Zentner *et al*. (1996) also reported that net economic return was higher in reduced tillage than in mouldboard plough tillage on the heavy clay soil. In contrast, some researchers reported that net economic returns were lower for reduced tillage systems (e.g., Malhi *et al*., 1988). Contrary to the findings of this study, Hoffman *et al*. (1999) found that net economic returns in the mouldboard plough tillage system were higher as compared to reduced and no-tillage systems.

Table-1. Weed density (m^{-2}) and diversity as affected by tillage systems in maize.

Tillage systems	Annual weeds			Perennial weeds		All weeds
	C. album	*E. colonum*	*C. prophetarum*	*C. dactylon*	*C. rotundus*	
No-till (NT)	17	62 ab	18	86 a	117 a	300 a
Reduced tillage (RT)	17	83 a	9	33 b	69 b	211 b
Deep tillage (DT)	20	44 b	6	35 b	101 ab	206 b
LSD	ns	26.77	ns	28.93	36.98	75.45
CV (%)	17.26	14.60	17.38	12.57	22.37	18.25

Means in the same column followed by different letters are significantly different from each other by LSD test at 0.05 level of probability.
Ns = non significant

Table-2. Weeds fresh and dry weight (kg m^{-2}) as affected by tillage systems.

Tillage	Weeds fresh weight	Weeds dry weight
No-till	1.37 a	0.277 a
Reduced tillage	0.97 b	0.229 b
Deep tillage	0.84 b	0.211 b
LSD	0.331	0.041
C.V.	17.96	9.87

Means in the same column followed by different letters are significantly different from each other by LSD test at 0.05 level of probability.

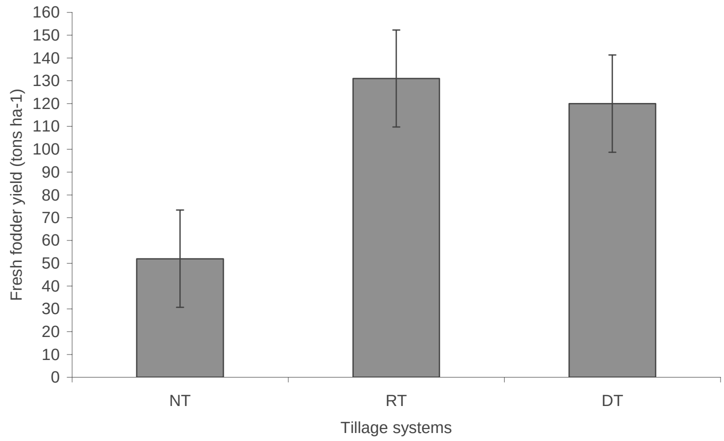

Fig 1. Effect of tillage systems on fresh fodder yield of maize. Vertical bars denote standard error.

Table-3. Gross income, variable cost and gross margin and efficiency coefficient for fodder maize as affected by tillage systems.

Tillage	Gross income	Variable Cost	Gross margin	Efficiency Coefficient (Output:input)
NT	12000	300	11700	1:40
RT	30407	1800	28607	1:17
DT	27923	3300	24623	1:08

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