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Effect of Deep Tillage Practices on Moisture Preservation and Yield of Groundnut under Rainfed Conditions

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ABSTRACT

A field experiment was conducted for two consecutive years to see the effect of various tillage depths on pod yield of groundnut and soil moisture status under rainfed conditions of Chakwal. Different implements used were mouldboard, chisel and disc ploughs alongwith cultivator as control. Data showed a significant effect of deep tillage on groundnut pod development and its yield. Each increase in tillage depth significantly affected these parameters. Highest number of developed pods and yield was noted with moldboard plough and the lowest in case of cultivator each year. More number of pods and pods yield was recorded during first year than second year. Economically highest net return was received from moldboard plough (Rs. 6652) followed by chisel (Rs. 4927) and least by disc plough (Rs. 2227) over cultivator. Post harvest soil analysis showed a positive effect of tillage depth on moisture contents of soil.

Key Words: Groundnut; Tillage implements; Yield; Economics; Moisture contents

INTRODUCTION

Groundnut (*Arachis hypogaea* L. Monech), also known as peanut and earthnut, is an important oilseed crop, seed containing 50% oil, 25-30% protein, 20% carbohydrates and 5% fiber and ash (Fageria *et al*., 1997). Groundnut is successfully grown where rainfall during the growing season exceeds 500 mm (Gibbson, 1980). In Pakistan, it is well adapted to annual rainfall of 400-1150 mm and best suited to sandy to sandy loam soil. Its seasonal crop water requirement is 500-700 mm and allowable moisture depletion in root zone is 40%. Most sensitive period for water shortage is flowering followed by yield formation period (Anonymous, 1997). Soil moisture is the life blood for plant growth constituting 80-90% of herbaceous plants and transport medium for nutrients from soil to plants (NFDC, 2003). The agriculture in the barani tract is dependent on rainfall which is very erratic and two-third of it is received in the monsoon, so moisture conservation is very crucial for successful crop production (Rashid *et al.,* 2000). The absorption of moisture depends upon the time and amount of rainfall, rate of evaporation and the type and physical condition of the soil (Hatam & Abbasi, 1994). Rainfed (barani) lands which constitute 20% of the cropped area fall under Agro Ecological Region (Punjab-V) where rainfall ranges from 1000 mm year^{-1} in the north-east to 200 mm in the south-west where deep ploughing is needed to improve moisture infiltration (PARC, 1980). The groundnut water use efficiency varies from one area to another with satisfactory groundnut yields (Kassam *et al*., 1975; Reddy, 1977; (Stansell *et al*., 1976; Pallas *et al*., 1977; Gorbett & Rhoades, 1995).

A farmer manages the soil through tillage for loosening compacted soil for improving water infiltration, breaking hard pans to a depth of 30-50 cm, for facilitating root growth for good crop establishment and water use efficiency (Anonymous, 1997), destroying weeds, incorporating crop residues and amendment into soils (Prihar, 1990). Physical conditions detrimental to root proliferation in subsoil are frequently related to tillage pans that develop below plough layers (Gill & Aulakh, 1990; Ishaq *et al*., 2001). Tillage pans have high bulk densities, few macro pores for roots to grow through and a mechanical impedance great enough to markedly reduce root growth rates (Rafiq, 1990; Hassan & Gregory, 1999). Tillage operation over several years may lead to compacted layers in field soils. Ploughing at the same depth year after year reinforces the pan development, so subsoiling (extra deep ploughing) may be the only way to breakup this pan (FAO, 1999). The role of deep tillage in ameliorating plough pans, hard pans or naturally occurring dense soil layers has been investigated by many workers (Vepraskas *et al.,* 1986; Reddy *et al*., 1987; Campbell *et al*., 1994; Rashid *et al.,* 1994; Akhtar *et al*., 1994). Successful tillage systems and practices have been developed specifically for proper moisture conservation in the rainfed areas and a large array of tillage implements have been tested (Khan *et al*., 1986; Hobbs *et al*., 1986; Chaudhry *et al.,* 1995; Khan, 1996; Gill & Akhtar, 2002).

Considering the importance, a study was planned with the objective of seeing the effect of different tillage implements (depths) on soil moisture conservation and their impact on groundnut yield and economics under rainfed conditions of Chakwal.

MATERIALS AND METHODS

A field experiment was conducted at Barani Agricultural Research Institute, Chakwal in two consecutive years. The test crop sown in the experiment was groundnut (variety BARI.89). Four different implements tried were mouldboard plough, chisel plough, disc plough and cultivator. Deep ploughing in the respective plots of each implement was done only once in January each year and

field was left open till sowing of crop i.e. in the month of April. Before sowing the crop, the seed bed was prepared with the help of cultivator. Selection of the field was done by keeping the past history of the field in mind. Neither of the field was deep ploughed at least three years ago. Field selected each year was free from salinity /sodicity hazards (pH ranged from 7.6 to 7.7, ECe 1.8 to 2.2 dS m^{-1}) with low in organic matter (0.45-0.50 %) and medium in available phosphorus (5.0-7.0 mg kg^{-1}) having sandy loam texture. Nitrogen, P_2O_5 and K_2O @ 20-80-20 kg ha^{-1} were applied at sowing, respectively. The crop was sown in the first week of April and harvested at the end of October each year in a randomized complete block design (RCBD) with four replications having plot size of 58 m x 9.6 m. After harvesting the crop, pod yield data was recorded and analysed statistically (Steel & Torrie, 1980). Economics of deep ploughing was also calculated each year. For this purpose, yield of the plots where cultivator used, was considered as control. Hence use of cultivator and fertilizer cost were common for all the plots.

RESULTS AND DISCUSSION

Rainfall. The rainfall data (Table I) showed that during the first year more rain was received than the second year from date of deep ploughing to date of harvesting. More over during first year the rain was more than 500 mm (522.15 mm) from sowing to harvesting time of the crop which was less than 400 mm (382.11 mm) during second year in the same period. It was also noted that in the first year, from deep tillage to sowing time, less rain (127.25 mm) was received than the second year (161.81 mm).

It was further noted that during both the years, maximum rain (180.36 & 137.08 mm) was recorded in the month of August (Fig. 1) than any other month of the study period.

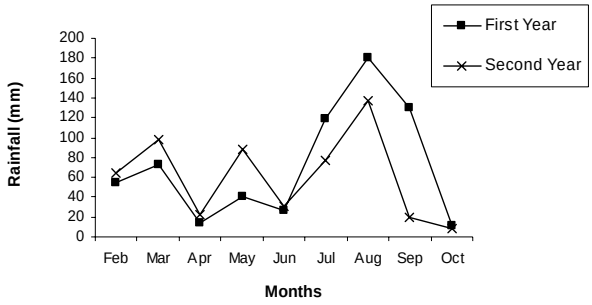
Table I. Rainfall received during study period

	Rainfall received (mm)	
	First year	Second year
Rainfall from date of deep ploughing to date of sowing	127.25	161.81
Rainfall from date of sowing to date of harvesting	522.15	382.11
Rainfall from date of deep ploughing to date of harvesting	649.40	543.92

Table II. Moisture percentage in soil during study period

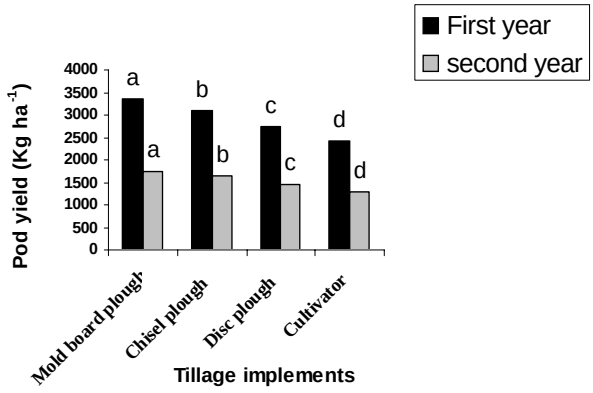
	Soil moisture (percent)	
	First year	Second year
Sowing time	9.50	5.26
Harvesting time	3.04	2.36

Fig. 1. Rainfall received during different months



SD (first year = 40.85, second year = 55.45) , SE (first year = 60.44, second year = 72.16)

Fig. 2. Pods yield of groundnut as affected by deep tillage



LSD (First year = 85.30, Second year = 52.75)

However, minimum rainfall was recorded (11.43 & 8.65 mm) during the month f November. As it is said that rainfall is erratic and uncertain in the rainfed area, so 130.53mm of rainfall was received during September in first year and 19.22 mm of rainfall was received during September in second year. This data of rainfall is also supported with the findings of Gibbson (1980) and Gorbett and Rhoades (1995).

It was further observed that more moisture was present in the soil at sowing (9.50%) and harvesting (3.04%) time during first year than at sowing (5.26%) and harvesting (2.36%) time during second year (Table II). This data is similar with that of Obaid (1996) who described the rainfall pattern of different tehsils of Attock district from 1989-1993 and found that it was quite variable among tehsils and months. Groundnut can be grown well in tracts which receive an annual well distributed rainfall of 50-125 cm which can be preserved by ploughing twice with mouldboard plough (Singh, 1998).

Number of developed and undeveloped pods. The data presented in table 3 showed that number of developed pods were significantly higher in mouldboard plough treated plots as compared to other treatments. Maximum numbers

Table III. Number of pods developed per five plants

Treatments	First year		Second year	
	Developed pods	Non developed pods	Developed pods	Non developed pods
Mouldboard plough	709 a	131 bc	286 a	80 a
Chisel plough	643 b	122 c	161 c	51 b
Disc plough	550 c	140 ab	190 b	62 b
Cultivator	506 d	150 a	132 d	86 a
LSD	28.74	17.38	12.76	11.85

Table IV. Economics of deep tillage

Treatments	Increased yield over cultivator (kg ha^{-1})	Yield in term of rupees ha^{-1}	Additional cost of deep tillage (Rs.ha^{-1})	Net return (Rs. ha^{-1})
Mouldboard plough	927	6952	300	6652
Chisel plough	697	5227	300	4927
Disc plough	337	2527	300	2227

of developed pods (709 & 286) were recorded in mouldboard plough treated plots and least (506 & 132) in cultivator treated plots in both the years.

Means sharing same letters are statistically at par at 5% level of probability. During first year, chisel plough had significantly more (643) developed pods than disc plough (550) while in the second year, the trend regarding developed pods of these two implements was noted reverse (190 in disc plough & 161 in chisel plough). As regards non developed pods, maximum numbers were observed in cultivator treated plots followed by mouldboard, disc and chisel ploughs, respectively. The results are in line with Anonymous (1997) and Rashid *et al*. (2000).

Pod yield. There was a positive effect of deep tillage on pod yield (Fig. 2). Preparation of seed bed to a greater depth has resulted in significant increase in yield as compared to shallow tillage i.e. cultivator during both the years. A significantly higher yield was observed as the tillage depth increased i.e. highest in case of mouldboard plough (3340 & 1758 kg ha^{-1}) and the lowest in case of cultivator (2412 & 1300 kg ha^{-1}) for the two years, respectively. The better results of deep ploughing may be due to the reason that the soil became softer and needles were facilitated for penetration in to the soil. Deep ploughing might be resulted in better conservation of soil moisture, which ultimately was used more efficiently by the crop for longer periods as compared with shallow ploughing.

During second year, the overall yield was low as compared to first year which might be due to the low rainfall in the second year while during first year, rainfall was quite sufficient and well in time. Similar explanations were given by Chaudhry *et al*. (1995). FAO also described the results of Kenya study and found the yield of groundnut from 732-1870 kg ha^{-1} with average yield of 1320 kg ha^{-1} (FAO, 1996). The results are also in line with those of Kassam *et al*. (1975), Rashid *et al*. (1994), Akhtar *et al*. (1994) and Khan (1996).

Economic analysis. Economic analysis (Table IV) showed that maximum net return was obtained when soil was tilled with mouldboard plough (Rs. 6652) followed by chisel plough (Rs. 4927) and least by disc plough (Rs. 2227) over cultivator. Gross margin of Rs. 8702 acre^{-1} for groundnut was indicated by the results of farm demonstration centers of On Farm Water Management kharif 1994-95 (Anonymous, 1997).

CONCLUSIONS

The conclusions drawn from this study are:

(i) deep ploughing by mouldboard plough significantly increased the pod numbers and yield of groundnut

(ii) deep tillage practices were quite effective in preserving soil moisture contents through precipitation and its utilization by the groundnut which is a deep rooted crop

(iii) ploughing with mouldboard and chisel ploughs returned three (Rs. 6652) and two (Rs. 4927) times more money respectively, as compared to disc plough while disc plough provided an additional amount of Rs. 2227 over cultivator.

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