Pakistan J. Sci Ind. Res., Vol. 31, No. 7, July 1988

THE INFLUENCE OF SIMULATED SOIL EROSION AND RESTORATIVEFERTILIZATION ON MAIZE AND WHEAT PRODUCTION

Muhammad Shafiq, M. Ismail Zafar, M.Z. Ikram and A.Y. Ranjha

National Agricultural Research Centre, Islamabad

(Received October 20, 1987; revised July 24, 1988)

Few attempts have been made to identify the yield limiting effect of soil erosion/desurfacing. The objective of this study was to determine the effect of moderate desurfacing on the yield of crops and restore the reduction in yield with the application of fertilizers. Maize and wheat yields were reduced by 50 and 51% respectively due to desurfacing. These losses were restored with the application of fertilizer 150-100 kg NP/ha for maize and 90-60 kg NP/ha for wheat. Lower yields under desurfacing are attributed to poor fertility status and available water holding capacities (AWHC).

Key words: Soil erosion, Productivity, Fertilization.

INTRODUCTION

Though erosion is a natural process, it has become accelerated by man's activities and presents a severe challanges to soil fertility and productivity due to soil lost in a field. Faced with declining productivity in eroded field, farmers apply fertilizers to restore their yields. The rising cost of fertilizers and related problems are placing great stress on revival of soil productivity.

Soil erosion causes a loss in productivity through physical, chemical and biological processes. In general the AP horizon of eroded soils have higher bulk density, lower organic matter and fertility status, Batchelder *et al.* [1], Frye *et al.* [6] which effect crop yields.

Beasly [3] reported that with 5 and 15 cm of top soil erosion decreased 15 and 30% productivity. Battison *et al.* [2] stated that yields on severly eroded areas ranged from 44 to 80% of those on control sites. The yield reductions have been related to changes in AWHC and in nutrient contents of the soil. Lohane [8] stated that on black soils of the Namol valley, in a season following bad erosion, a 30% fall in wheat yields is common. Bruce [4] observed that the yields on severely eroded areas was about 50% of that on slightly eroded areas. Englstand *et al.* [5] reported 50% decrease in corn yields by artificially exposing the sub-soil. However the application of 30 to 58 kg/ha additional N–fertilizer restored its productivity to unaltered soil. Riply *et al.* [(10] reported that artificial removal of 7.5 and 15 cm of top soil caused an average of 21 and 58% decrease in yield of barley respectively. Massee [9] observed 70% yield on plots where 12 inches. of top soil was removed. Only by adding 67 kg/ha of N to this area the production could be lifted to unfertilized top soil.

The objective of this study was to determine the effect of desurfacing (10 cm, moderate erosion) on the productivity of soil and its restoration with the use of fertilizers.

MATERIAL AND METHODS

The experiment was conducted on a silt loam soil at Mangial, Fatehjang. The soil belonged to missa soil series which generally occures in pothwar. The study started during kharif 1986 (maize) and followed by wheat during rabi 1986-87. The work employees artificial desurfacing, to simulate the removal of top soil. The treatments comprised of combinations of three fertilizer rates (F_1, control, F_2, 90-60 NP_2O_5 kg/ha and F_3, 150-100 N,P_2O_5 kg/ha) and two levels of desurfacing (E_1, top soil in contact and E_2, top 10 cm desurfaced). The layout plan was randomized complete Block design with three replications of 2 x 2 meters plot size. The plots were properly bunded and 0.5 m. apart from each other to avoid surface runoff – runon condition. They were water tight and only incidental rainfall was the source of moisture. Composite soil samples were collected from the desurfaced and non desurfaced plots. The physio-chemical analysis was carried out and results are given in Table 1. All the fertilizers were applied at the time of sowing by broadcast and mixed with the help of showel. The maize was sown through dibbling and wheat crop with hand drill. Under each treatment five plants were selected for their growth rates (height) monitoring through out the growing season at an interval of 15-20 days. The average heights observed under different treatments are given in Fig. 1 and 2. At maturity all plots under each treatment were harvested for the determination of yield and yield components. Data was analysed statistically and Suncan's Multiple Range test was applied for comparison.

Table 1. Physio-chemical characteristics of soil

Depth (cm)	Sand (%)	Silt (%)	Clay (%)	Tex. Class	B.D.	Moisture contents (%) 1/3 Bar	15 Bar	AWHC
A –Physical								
0 – 15	8	75	17	Silt loam	1.47	23.5	11.05	12.45
15.30	6	76	18	Silt loam	1.49	22.5	11.92	11.58

Depth (cm)	O.M. (%)	Total N (%)	AB–DTPA extractent (ppm) P	K	Zn	Co	Mn
B – Chemical							
0 – 15	0.68	0.053	6.76	83.07	0.60	6.02	11.7
15.30	0.54	0.043	1.68	64.35	0.54	6.44	5.4

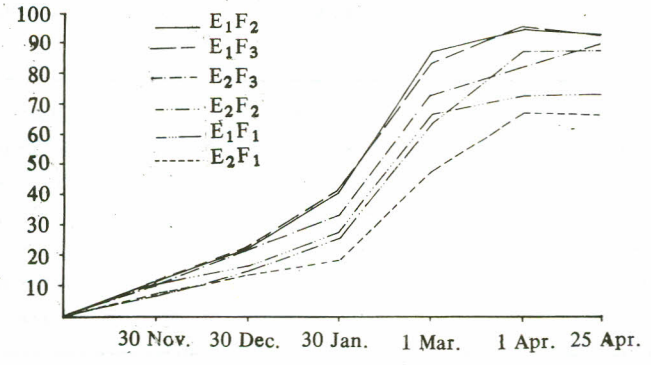

Fig. 1. Plant growth rate of maize as affected by desurfacing and fertilizer application.

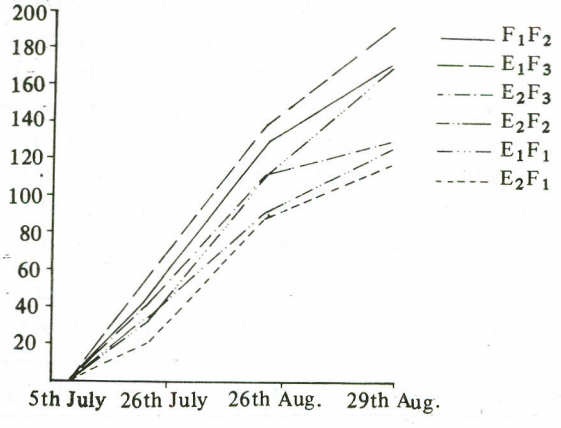

Fig. 2. Plant growth rate of wheat as affected by desurfacing and fertilizer application.

RESULTS AND DISCUSSION

Soil properties. The physio-chemical properties (Table 1) indicated that the subsoil has the higher bulk density. The available water holding capacities (moisture content at 1/3 bar and 15 bar) of top soil was 12.45% and subsurface 11.52% which was 6% less than the top soil. Like-wise the fertility of the sub-soil is quite low as compared to top soil. It was also observed visually that the water infiltrated readily through the top soil but remained standing for some time especially after heavy rainfall on the exposed soil.

Yield Components. Maize. The desurfacing of the soil affected the yield components (plant height, cobs/plant) significantly (Table 2). Plant height was lowest and even the application of fertilizers could not compensate the fertility loss. Similarly the proportion of plants without cobs was high where surface soil was removed. Fig 1 indicated that the plant heights through out the growing season were low under desurfacing and fertilization increased the heights under both desurfaced and non-desurfaced conditions.

Wheat. Desurfacing of the top soil and fertilizer application affected the plant growth (Fig. 2) and yield components (plant height and tillers m^{-2}). However this effect was not significant. Lowest height and tillers m^{-2} were observed where the surface soil was removed and fetilizer was not applied. The plant height and tillers m^{-2} were maximum under natural soil conditions and fertilizer application 150-100 kg/ha.

Straw and grain yield Maize. The grain and stalk yields were affected significantly with desurfacing and application of fertilizers (Table 2). The lowest yields of 1735 and 961 kg/ha of stalk and grains respectively were observed where soil was desurfaced and without fertilizer application. This produced 56 and 50% lower

Table 2. Effect of desurfacing on yield and yield components of maize.

Treatments	Plant height -2 (M)	Plants with cobs (%)	Yield (kg/ha) Stalk	Yield (kg/ha) Grain
E1 F1	1.60 ab	70 a	3912 c	1931 b
E1 F2	1.71 a	76 a	3957 b	2655 a
E1 F3	1.92 a	88 a	6146 a	3097 a
E2 F1	1.08 c	27 b	1735 e	961 c
E2 F2	1.18 c	29 b	3026 d	1309 bc
E2 F3	1.26 bc	46 b	3775 c	1601 b
LSD (0.05)	0.34	21.6	654.4	605.5

Table 3. Effect of desurfacing on yield and yield components of wheat

Treatments	Plant height (cm)	Tillers -2 (M)	Yield (kg/ha) Stalk	Yield (kg/ha) Grain
E1 F1	73.0 b	221.8 c	3251 cd	2065 c
E1 F2	92.0 a	356.7 ab	5782 b	3755 b
E1 F3	92.1 a	439.3 a	7078 a	5510 a
E2 F1	67.2 b	208.7 c	2419 d	1005 d
E2 F2	87.3 a	288.0 bc	3804 c	2609 c
E2 F3	90.7 a	420.7 a	5631 b	4368 b
LSD (0.05)	13.7	112.2	927.7	1038.2

E1 – Top soil F1 – Control E2 – Desurfaced F2 – 90-60 NP kg/ha F3 – 150 -100 NP kg/ha

yields of stalk and grains respectively over the natural top soil, yields. The application of fertilizer affected the yields of stalk and grains significantly under both the soil conditions. Highest production (6146 kg/ha stalk 3097 kg/ha grain) was observed with the application of fertilizer 150-100 kg/ha on top soil. The reduction in yield due to desurfacing with 150-100 kg/ha fertilizer rate was 39 and 48% for stalk and grain respectively. It was further observed that with the application of fertilizer at a rate of 150-100 kg/ha, the response to fertilizer was increased.

Wheat. The results given in Table 3 indicated that the straw and grains yields of crop were affected significantly by desurfacing and fertilizer application. Like the maize crop, the lowest yields were observed when surface soil was removed and fertilizer was not applied. The desurfacing reduced the yield of straw and grains by 26 and 51% respectively. Highest yields of 7078 and 5510 kg/ha of straw and grain were achieved with the application of fertilizer 150-100 kg/ha respectively on top soil. The fertilizer rate i.e. 150-100 kg/ha produced 5631 and 4368 kg/ha of straw and grains respectively on desurfaced soil which were, about 20% lower than the treatment where fertile top soil was in-contact. It was further observed that reduction in yield due to desurfacing can be restored with the application of fertilizer at a rate of 90-60 kg/ha. It was further observed that the response to fertilizer was increased under desurfacing conditions. The cost benefit analysis was carried out (Table 4) and observed that

Table 4. Cost benefit ratios of fertilization for maize and wheat under control and desurfaced conditions

Treatments	Maize	Wheat
E1 F1	–	–
E1 F2	1 : 2.6	1 : 6.3
E1 F3	1 : 2.7	1 : 7.3
E2 F1	–	–
E2 F2	1 : 1.7	1 : 5.5
E2 F3	1 : 1.7	1 : 7.0

ratios were low under maize than in wheat. The desurfacing also lowered the value under both maize and wheat.

It can be concluded that the efforts should be made to avoid soil erosion to maintain the soil fertility/productivity. If the soil is not looked after its fertility will have to be restored with the application of fertilizers which is an expensive alternative.

REFERENCES

1. A.R. Batchelder, and J. N. Jones, Subsoil. Agron. J., **64** (5), 648 (1972).
2. L.A. Battison, R.A. Mc. Bride and M.H. Meder, (1983) Agron. Abstt., 195 (1983).
3. R.P. Beasley, *Erosion and sediment population Control* (Lowa State Uni. Press, Aes., 1972).
4. R.R. Bruce, A.W. White, A.W. Thomas, G.W. Langdele and H.F. Parkins, Agron. Abstt. 245 (1984).
5. O.P. Engalistand, W.D. Shrder and L.C. Dumanil Soil Sci. Soc; Am. Proc., **25**, 494 (1961).
6. W.W., Frye, S.A. Ehelhar, L.W. Murdock and R.L. Blevins, Soil Scil. Soc. Am. Proc. **46** (5), 1051 (1982).
7. M.A., Fosberg, M.B. Brodahl, A.L. Falen, D. Walker and R.C. Mohlar (1983).Idaho. Agron. Astt., 197 (1983).
8. R. Lohane, *Soil Erosion: Can We Dam the Flood,* ECOS No. **254** (1980).
9. T. Massee, Agri. Res. USDA ARS **31** (2) 14 (1983).
10. P.O. Riply, W. Kalbfleish, S.J. Bourget and D.J. Cooper *Soil Erosion water, demage prevention, control,* pub. No. 1083 (Res. Branch Dep. of Agri., Ottawa, Ontario, (1961).