

SOIL AND WATER CONSERVATION RESEARCH INSTITUTE, CHAKWAL



Dr. Obaid-ur-Rehman

Chief Scientist

Tel: +92-543-662015

Cell: +92-332-5645033

Email: sawcri@gmail.com

OVERVIEW

The main soil problems of Pothohar include soil erosion, soil moisture stress and low soil fertility that are mainly caused by uneven topography and poor management of land and water resources of the area. Climate change has resulted in erratic rainfall, longer dry spells and decreased water availability to crops around the world. Rainfed agriculture is more prone to these climatic variations. Major agriculture areas are rain-fed with 60% share in crop production; covering 80 % of global agricultural area. But agricultural production is quite less in arid and semi-arid parts of rain-fed agriculture due to erratic rainfall, poor soil and water management practices. The careful management of these natural resources is essential for food security and environmental protection. Sustainable use of these resources is imperative to socially, economically and ecologically viable communities. High intensity rains generate surface runoff that flashes over sloppy lands. This surface run off when flashes with high speed from higher to lower elevation removes upper soil layer and causes loss of fertile soil and erosion. The rainfall in these areas varies from less than 200 mm to over 1000 mm of which almost sixty to seventy (60-70) percent rain is received in the months of July to September. To address this twin menace of the area Soil and Water Conservation Research Institute was established by the Govt. of Punjab. Main objectives of the institute are; to develop technologies for soil conservation and efficient use of available water for sustainable and profitable crop production. To employ the findings and develop technology for different climatic zones of rainfed area, Soil and Water Conservation Research Station, Fateh Jang and Sohawa were also established. The research stations were upgraded and strengthened in order to boost agricultural production and improve the living standard of the farming community of rainfed tract, through conservation and optimum use of natural resources. The institute has standardized soil and water conservation technologies after extensive research on soil and water conservation keeping in view the specific Agro-climatic zones of rainfed areas. Moreover, the institute has started capacity building of professionals and farmers on various soil and water conservation technologies and trained more than 6000 farmers and professionals.



Performance Evaluation of Different Soybean Varieties under Different Time of Sowing in Rainfed Areas of Pothwar.

There is a need to work on the adaptability of soybean cultivars under different climatic conditions of Pakistan to ensure the self-sufficiency in quality food, feed, and edible oil production ultimately a step forward for achieving sustainable food security along with significant improvements in soil health. The climatic condition and soil types of Pothwar region is vary from area to area, so, it is dire need to evaluate different soybean varieties in this area.

Table 1. Plant height and grain yield of different soybean varieties under different sowing dates

Treatments/ Varieties	Plant Height (cm)		Grain Yield (kg/ha)	
	SD-1	SD-2	SD-1	Sd-2
Rawal	56.07 b	34.53 ab	798.67 a	35.27 c
NARC-21	69.13 a	35.40 a	780.53 b	43.40 ab
Adv. Line	39.33 c	32.13 bc	101.93 c	45.60 a
Adv. Line	38.40 c	30.12 c	045.47 d	39.07 bc



Fig. 1. Soybean crop grown at SAWCRI, research Farm.

It is evident from the results presented in the Table 1 that variety NARC-21 showed highest plant height 69.13 cm followed by Rawal which gain 56.07 cm height under 1st sowing date (7th July, 2023). However, advanced lines sown in 1st sowing date appeared similar in plant height as in 2nd date of sowing (24th July, 2023). Similarly, Rawal showed most prominent result regarding soybean yield (798.67 kg ha⁻¹) followed by NARC-21 (780.53 kg ha⁻¹) in the 1st sowing date. However, adv., lines showed no satisfied results regarding yield in both sowing dates as well as the Rawal and NARC-21 also showed similar trend in 2nd sowing date. Thus, this experiment was designed to accommodate suitable soybean variety in pre-existing cropping system (wheat-fallow) in order to develop new cropping system i.e wheat-soybean in the Pothwar region without compromising on wheat growing crop in the area.

Impact of organic manures on nutrient loss for sloppy lands

Soil erosion is one of the most significant ecological restrictions to sustainable agricultural production on undulating topography. Unsustainable practices on slope gradients pose a series of problems, such as flood and siltation, for downstream portions of the watershed. In Pakistan, the Pothohar Plateau cover an area of 5.49 Mha, and the agriculture sector is directly or indirectly dependent on rainfall. Almost 70-80 percent rainfall occurs in the months of June to August. These torrential rains sweep away essential nutrients leaving behind unfertile soil. No data regarding soil, water and nutrient losses are available relating to these areas. The aim of this study was to select the best organic manure according the environmental condition of Fateh Jang and to access the improvement of fertility level in sloppy lands by using these manures.

Table 2. Topography and soil amendment effect on maize grain yield (kg ha⁻¹)

Slope Gradients (%)	Control	FYM Compost	Fruit Vegetable Compost	Vermi Compost
1	2970 H	3990 E	6010 A	5960 B
5	2210 J	3570 G	5530 C	4770 D
10	1580 K	2920 I	4770 D	3810 F

Table 3. Topography and soil amendment effect on Maize straw yield (kg ha⁻¹)

Slope Gradients (%)	Control	FYM Compost	Fruit Vegetable Compost	Vermi Compost
1	5010 G	5680 E	9470 A	9350 B
5	3995 K	5180 F	8190 C	6880 D
10	2987 L	4695 J	4910 H	4870 I

It is evident from the data presented that at 1% slope gradient with fruit vegetable compost performed best followed by vermi compost and farmyard manure. At 5 % slope & 10 % slope gradient, similar trend in yield was observed it means organic amendment application at sloppy area is sustainable practice to overcome losses due to steep slope gradients.

Effect of zeolite on growth and yield of millet crop as applied alone and with gypsum in rainfed area

A study was planned for testing and evaluation of zeolite mineral for soil moisture conservation and slow

release of fertilizers in millet crop in Kharif and wheat crop in Rabi. Zeolite is a hydrated allumino-silicate mineral having capability to entrap water molecules in its structure for longer period of time, making it easier for plants to absorb water for its growth. Zeolite also has the ability to adsorb cations especially NH_4^+ and K^+ to its negatively charged surface and hence releases cations slowly. The major feature of zeolite is enhanced water holding capacity of soil containing it and high CEC (100-150 $\text{CMol}^+ \text{kg}^{-1}$).

Table 4. Effect of different treatments on grain and biomass yield of Millet

Treatments (t ha^{-1})	Grain yield (kg ha^{-1})	Biomass yield (kg ha^{-1})
Control	1296	8645
Zeolite @ 1 t ha^{-1}	1332	9130
Zeolite @ 2 t ha^{-1}	1358	9766
Zeolite @ 2.5 t ha^{-1}	1537	9386
Zeolite @ 1 t ha^{-1} + Gypsum @ 2.5 t ha^{-1}	1570	10604

Role of microbial inoculations on the growth and yield of crops under rain fed conditions

The major reason of low yield in arid and semiarid areas is low availability of moisture & low fertility during crop growing period. Climate of these regions is characterized by seasonal rainfall, intermittent dry spells, recurrent drought years and high evaporative demand. The main objective of this study was to evaluate the role of plant growth promoting Rhizo bacteria (isolated from drought prone area for enhancing crop yields under rainfed conditions by enhancing availability of nutrients to crop).

Table 5. Effect of microbial inoculation on Groundnut grain yield (kg ha^{-1})

Treatments	Year 2019	Year 2020	Year 2021	Year 2022
Control	920 D	1548 D	1620 D	873 D
G1 Inoculum	1040 C	2173 C	2208 C	1740 C
G2 Inoculum	1210 A	2533 A	2622 A	2382 A
G3 Inoculum	1160 B	2275 B	2425 B	2026 B

Table 6. Effect of microbial inoculation on Groundnut Straw yield (kg ha^{-1})

Treatments	Year 2019	Year 2020	Year 2021	Year 2022
Control	947 C	2995 D	2810 C	1020 D
G1 Inoculum	1140 B	3114 B	3077 B	2040 C
G2 Inoculum	1310 A	3235 A	3420 A	2860 A
G3 Inoculum	1260 A	3009 C	2960 BC	2488 B

Water productivity enhancement through multiple mulching techniques on millet fodder yield & residual effect on wheat

The Pothwar region is facing immense problem of moisture depreciation resulting in lower crop productivity. Different mulching techniques are used to enhance moisture conservation under rainfed conditions. Mulching also reduces erosion while enhancing the soil's ability to hold more moisture and reduces evaporation losses and ultimately reduces the irrigation requirements. It economizes the use of fertilizer and saves labor cost. During the present study various moisture conservation approaches were applied during Kharif on millet crop (harvested at 50% heading stage) and their residual effect was monitored on wheat in Rabi.

Table 7. Effect of different mulching techniques on wheat crop

Treatments	Plants m^{-2}	Tillers m^{-2}	Plant height (cm)	1000-grain wt (g)	seed yield (kg ha^{-1})
T1 (Control)	138.33a	298.3b	99.6a	38.4c	2373c
T2 (Gyp)	141.67a	294.4b	110.6ab	38.5c	2482c
T3 (Hydrogel)	140.67a	338.7ab	119.3a	40.9b	3054b
T4 (Gyp+Gel)	144.33a	392.7a	120a	43.8a	3579a
T5 (Polythene sheet)	143.33a	327ab	117a	41.7ab	2958b
SE±	12.4	65.9	15.4	2.17	418

According to the data presented in Table 7 it is shown that highest significant biomass yield and grain yield of wheat was found with gypsum and hydrogel in combination due to enhanced moisture conditions.

Comparative Yield Performance of Various Perennial Grasses and Their Effect on Soil Erosion and Soil Properties in Steep Slope Gradients in Fateh Jang Area

The carrying capacity of the highly depleted rangelands of Pakistan could be increased manifold by reseeding with palatable grass species. In addition to the meager availability of forage, the area is overstocked 2 - 3 times of the carrying capacity and livestock are under-fed to their low performance.

New study was planned to check the adaptability of three grass species for climatic condition of Fateh Jang & their yield performance and effect on soil erosion and soil properties in steep slopes (15 & 20%) is being observed in Fateh Jang.

Table 8. Parameters of Grasses Recorded at Medium Rainfall Area

Name	Slope Gradients	Biomass 10 m ²	Biomass (kg ha ⁻¹)
No grass	15	-	-
Vetiver	15	1.55	1550
Mot grass	15	9.41	941
Burwa grass	15	10.65	1065
No grass	20	-	-
Vetiver	20	1.46	1460
Mot grass	20	8.57	8570
Burwa grass	20	10.91	10410

The data revealed that all grasses grew well and the maximum biomass yield (1065 kg ha⁻¹) was produced by Burwa.

Testing and evaluation of locally available super water absorbent for moisture conservation in wheat

Moisture stress is the second most important constraint to agricultural productivity in the Pothwar region. The entire tract is dependent on rainfall for crop production. Mostly, 70-80% of annual rainfall is received during monsoon (July-September). Generally, the winter crops are more affected by drought, resulting in low yield of crops especially wheat which is the staple food. Successful crop production in rain-fed areas need additional soil moisture from preceding season. It has been reported in literature that polyacrylamides absorb later and may be effective for moisture conservation in rain-fed areas for successful agriculture. Therefore, this study was planned to test and evaluate locally available

water absorbent for soil moisture conservation to improve wheat yield under rain-fed environment.

The results presented indicated that the treatment Hydrogel @ 7.5 kg ha⁻¹ benefited most despite the fact that hydrogel @ 10 kg ha⁻¹ enhanced both grain and biomass yield of wheat at the maximum. Soil moisture percentage was determined through gravimetric method.

Table 9. Effect of different hydrogel rates on wheat grain and straw yield (kg ha⁻¹)

Treatments	Grain Yield (Kg ha ⁻¹)	Biological yield (Kg ha ⁻¹)
Control	2722	7666
Hydrogel @ 5kg	2834	7952
Hydrogel @7.5kg	3163	8248
Hydrogel @10kg	3182	8274



Fig.2 . Effect of different doses of hydrogel on wheat growth.

MISCELLANEOUS ACTIVITIES

1. Organized two Research and development board meetings with the professionals, stakeholder, representees from the farming community to discuss the water saving related issues and research related programs
2. Submitted seven projects in PARB related to manage water conservation issues in rainfed area
3. Celebrated World International Soil Day on 05-12-2023
4. One Research Technology (Gypsum for moisture conservation) was approved by R and D board 2022.

PUBLICATIONS

Muhammad Yunas, Sarfraz Ahmed, Tahir Majeed, Bashir Ahmad, Obaid ur rehman, Majid Rahim, Sultan Ahmed Rizvi, Sher Afzal, Riffat Bibi, Safia Naureen

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SENIOR SCIENTISTS

Sarfraz Ahmad
Principal Scientist
0331-5244964
sarfrazjm@gmail.com

Dr. Sultan Ahmad Rizvi
Senior Scientist
0333-4343445
engrsultan68@yahoo.com

Dr. Riffat Bibi
Senior Scientist (Soil Science)
0332-5383403
riffat_ises@yahoo.com

Mr. Majid Rahim
Senior Scientist (Soil Science)
0335-4470533
majidrahim1974@gmail.com

Mr. Muhammad Yunas
Senior Scientist (Soil Science)
0301-5060185
soilscientist2002@gmail.com

Azhar Mahmood Aulakh
Senior Scientist (Agronomy)
0343-0303049
azuaulakh@gmail.com