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Periodic Research

Evaluation of in-Situ Soil and Moisture Conservation Methods on Runoff, Soil & Nutrient Loss and Productivity of Jowar Crop

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Abstract

A field experiment was conducted during the *Kharif* season of 2013 at Agro-Ecology and Environment Centre, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola to study the effect of *in-situ* soil and water conservation measures on reduction of runoff, soil and nutrient losses, improvement in moisture retention, crop growth, water use efficiency and productivity of Jowar crop. There was total seven treatments viz. along the slope cultivation (T_1), along the slope cultivation with opening of tide furrow (T_2), across the slope cultivation with sub surface tillage (T_3), across the slope cultivation with opening of alternate furrow with sub surface tillage (T_4), Across the slope cultivation with opening of ridges and furrow (T_5), Contour cultivation with opening of alternate furrows (T_6) and Contour cultivation with opening of ridges and furrows (T_7). Biometric observations such as plant height and cob length were favorably influenced in treatment T_7 followed by treatment T_6, T_5, T_4, T_3, T_2 and T_1.Highest plant height (137.83 cm) and cob length (26.17 cm) was found in treatment T_7. Productivity of Jowar was favorably influenced by treatment T_7. Highest grain yield 11.20 q ha^{-1} was recorded in treatment T_7 followed by treatment T_6,T_5,T_4,T_3,T_2 and T_1.Water use efficiency was more dominant in treatment T_7 i.e. 1.41 Kg ha^{-1} mm^{-1} followed by 1.29 (T_6), 1.25 (T_5), 1.21 (T_4), 1.13 (T_3), 1.09 (T_2) and 1.04 in treatment T_1.Data regarding soil moisture content at various depth viz.,15 cm, 30 cm, 45 cm, and 60 cm shows that highest moisture content at all depth was found in treatment T_7.

Keywords: Jowar crop, cultivation, in-situ, rainfed, water use efficiency

Introduction

Rainfed agriculture to great extent depends on water saving technologies. Efficient rainwater management is crucial in rainfed agriculture. Its success depends on how best rainwater is conserved and utilized. Proper mechanical and vegetative structure can help to conserve the rainwater in situ and provide the quite essential moisture for crop growth. Soil and water conservation measures are basic resources essential for survival of human kind on earth. Ironically, very few people realize the importance of conservation and judiciously utilizing the soil, the greatest gift of nature. Soil and water conservation is so important because they are two of the key things needed to sustain life. Water conservation is important because it is a necessity for all living things. Water is most limiting natural resources in semi-arid region. In most of the areas only water available is rain water. Due to inadequate and uneven distribution of rainfall during growth span of crop, it becomes essential to supply water to plant by adopting *in-situ* soil conservation measures for increasing water use efficiency.

Indian agriculture mostly depends upon the monsoon rains receiving during June to September. Water is crucial input for augmenting agricultural production towards sustainability. Water is most limiting natural resource in arid and semiarid region. Due to inadequate and uneven distribution of rainfall during growth span of crop, it becomes essential to adopt *in-situ* soil moisture conservation measures for sustainable crop production in rainfed agriculture.

There are several soil and water conservation measures for reduction of runoff and soil loss such as strip cropping, contour and graded bunding etc. which not only controls the runoff more efficiently but also curtails the soil loss and enhanced the crop yield. In order to have the sustainable agriculture, maintaining soil properties in favourable proportion for a long

time conservation practices are necessary to overcome this problem. This can be feasible integration of managing the land on water basis. *In-situ* recharge of rain water needs reforms in cultivation practices in such a fashion that maximum rainfall get infiltrated in to the soil profile and it becomes available to the crop during prolonged monsoonic break and controls water crises in agriculture by the way of 'more crop per drop'.

Jowar is the third most important food crop of the country after rice and wheat both in terms of area and production. It is tropical crop. It grows well in at a temperature condition below 16^0 C is harmful for the crop. It requires a moderate rainfall between 30 and 65 cm. It is a popular crop of dry farming regions. Excessive moisture (above 100 cm) and prolonged droughts are harmful. Thus, the Study was conducted to evaluate the *in-situ* soil and water conservation effect through various land configurations for Jowar crop with following specific objective as to study runoff, soil and nutrient loss, to study on growth and yield of crops and to estimate the *in-situ* soil and moisture conservation.

Materials and Methods

Climate of the Agro-ecology & Environment Centre (Watershed Farm)

Akola is situated at latitude 20.70 North and longitude 77.070 East. It is an altitude of 925 ft. (282m) above sea level. Agro-ecologically the watershed area lies in sub region Eastern Maharashtra Platue, hot, moist, semi-arid, with medium black soil, medium to high available water holding capacity. The climate is semi dried monsoonic characterized by three distinct seasons viz, summer with hot and dry weather from March to May, monsoon, warm and rain from June to October and winter, dry mild from November to February. The mean monthly temperature of Akola is 20.5^0 C to 30.5^0 C with recorded minimum and maximum temperature of 120 C to 450C, in the month of December and May respectively. Akola district falls in assured rainfall zone of Maharashtra having an average annual rainfall of 750mm. (Anonymous 2013)

Experimental Design: The experiment was conducted in Randomized block design (RBD).

Sowing and Harvesting of Crop

Jowar crop (CSH-9) was sown on 26 June 2013 and harvested on 20th October 2013.The applied dose of fertilizer was 80kg N+40kg P_2O_5+40 Kg K_2O ha^{-1}

Treatment Details

Treatment	Description of treatment	Plot Size (m x m)	Area (ha)
T_1	Along the slope cultivation	100x10	0.10
T_2	Along the slope cultivation with opening of tide furrow	129 x 28	0.36
T_3	Across the slope cultivation with sub surface tillage	100x 10	0.10
T_4	Across the slope cultivation with opening of alternate furrow with sub surface tillage	100x 10	0.10
T_5	Across the slope cultivation with opening of ridges and furrow	122 x 28	0.34
T_6	Contour cultivation with opening of alternate furrows	129 x 28	0.36
T_7	Contour cultivation with opening of ridges and furrows	125 x 28	0.35

Soil Sampling for moisture determination

Soil samples were collected using screw auger at sowing, 30DAS, 60DAS, and 90 and at harvest for four depth's viz., 15 cm, 30 cm, 45 cm, and 60 cm respectively. Soil moisture per cent was determined gravimetrically (Piper, 1966). Monthly replication wise biometric observations were recorded for each treatment. For that five plants were selected from 2m x 2m size sub plot of main treatment plot. This treatment wise biometric observations viz height, cob length was recorded. The yield of the Jowar crop was recorded from the plot of size 2m x2m selected.

Water use efficiency

Water use efficiency for each treatment was calculated on the basis of yield of the crop and the total rain water use by that crop. Water use efficiency was calculated with the help of following formula.

Water use efficiency (kg ha^{-1} mm) =

$$\frac{\text{Grain Yield (kg ha}^{-1})}{\text{Total Water applied (mm)}}$$

Run-off Sample Collection and Analysis

The runoff from each plot concentrated at the outlet of runoff plot was measured by H-flume of 0.30 m depth installed as a runoff measuring device. The float type automatic stage level recorder was installed at the outlet of each gauging site. The runoff chart obtained from Stage Level Recorder gives a continuous record of depth of flow over the flume with respect to time. This stage graph will subsequently process to obtain the runoff rates and Peak rate of runoff volumes which will later use for further analysis.

Soil Loss: The soil samples from the run-off were collected during the season. After each storm the run-off samples were collected manually. Stirred 100 ml run-off water each from individual sample was taken into aluminium box. The weight dry soil from 100 ml run-off water was determined by weighing. The soil loss in total run-off volume was expressed in t ha^{-1}

Soil loss =

$$\frac{\text{Cumulative run-off volume (ml) x Soil loss in (ml)}}{100}$$

Nutrient Losses

Nutrient losses from various treatments plots were calculated by chemical analysis conducted in Soil Testing Laboratory Agro-ecology and Environment Centre, Dr. P.D.K.V. Akola Available N content in soil was determined by Alkaline Permanganate method given by Subbiah and Asija (1965). Available phosphorus content in soil was

determined by Olsen's method given by Jackson (1967). Available Potassium content in soil was determined by Flame Photometer using 1N Ammonium Acetate given by Jackson (1967).

Results and Discussion

Growth and Productivity

Data pertaining to growth parameters like plant height (cm), cob length (cm), grain yield and water use efficiency of Jowar (CSH-9) given in (Fig.1) indicated the favourable effects of contour cultivation with opening of ridges and furrow in medium soil. Higher mean plant height (137.83 cm), cob length (26.17 cm), grain yield (11.20 qha^{-1}) and average depth of root (27.10 cm) was observed in contour cultivation with opening of ridges and furrow (T_7) followed by T_6, T_5, T_4, T_3, T_2 and T_1. Munish Kumar et al. (2008) observed that the highest plant height of sorghum in ridge and furrow while the lowest was in under flat bed. The ridge and furrow methods of moisture conservation showed significantly higher number of functional leaves/plant in comparison to other practices. Highest grain weight/panicle (30.64 g) was recorded in ridge and furrow closely followed by in mulching (29.50 g) and the lowest was recorded under flat bed (27.03g).

The highest increase in Jowar grain yield was observed in T_7 (47.77%) followed by T_6(29.12%),T_5(25.32%),T_4(21.52%), T_3 (12.66%) and T_2 (5.06%) over T_1. Ramesh and S. Rathika (2009) concluded that, conservation of rain water through land configuration techniques viz., compartmental bunding, ridges and furrow and tide ridging have considerably improved the soil moisture, increase in plant growth parameters like plant height, leaf area index, root growth and dry matter production, yield attributes and yield of many field crops under rain fed condition in Alfisols ecosystem.

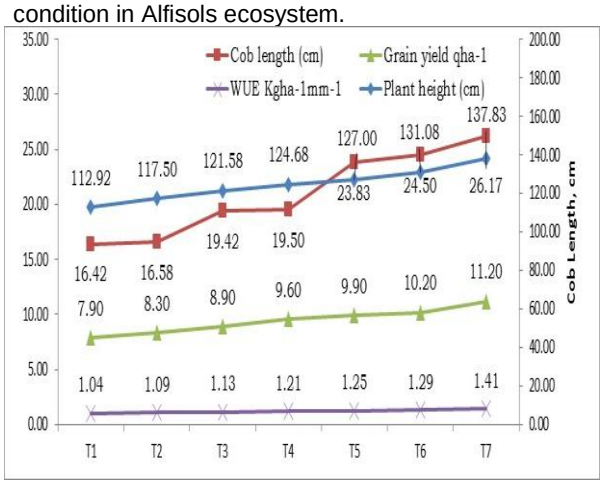

Fig. 1 Effect of Rain water conservation techniques on growth parameters, productivity and water use efficiency

Water Use Efficiency

Water use efficiency (Fig.1) in all treatments was ranged from 1.41 to 1.04 kg ha^{-1} mm^{-1}. Highest water use efficiency of 1.41 kg ha^{-1} mm^{-1} was observed in contour cultivation with opening of ridges and furrow i.e. (T_7) followed by T_6, T_5, T_4, T_3, T_2 and T_1. The lowest water use efficiency 1.04 kg ha^{-1} mm^{-1} was found in along the slope cultivation (T_1). Bhanavase *et al.* (2007) observed highest water use of 381mm in furrow treatment followed by tied ridges (3710mm) and compartment bunding with mulch. Oswal (1994) revealed that beneficial effects of ridges and furrows method of land configuration were recorded over flat bed method in terms of water use efficiency. Water use efficiency was 7.2 kg/ha/mm in pearl millet crop grown on ridges and furrows as against 5.1 kg/ha/mm in flat bed method in low rainfall areas.

***Insitu* soil and water conservation**

Data pertaining to *insitu* soil moisture content given in (Fig.3) indicated the favourable effect of contour cultivation with opening of furrows in medium soil.

Soil moisture

The maximum soil moisture content at harvest (Fig.2) up to the depth of 15-60 cm was observed 6.94 to 15.38 % in T_7 followed by T_6 (6.54 to 13.94 %), T_5 (6.17 to 13.08%), T_4 (6.04 to 12.57%), T_3 (5.54 to 12.17%), T_2 (5.12 to 11.94 %) and minimum in T_1 (4.17 to 11.17%). The maximum increase in soil moisture was observed in T_7 followed by T_6, T_5, T_4, T_3, T_2 and over T_1 at the time of sowing, 30, 60, 90 DAS and at harvest time. Kiran and Lingaraju (2004) reported that among the *in situ* moisture conservation practices, ridges and furrow and compartmental bunding were found beneficial in conserving higher soil moisture as compare to flat bed.

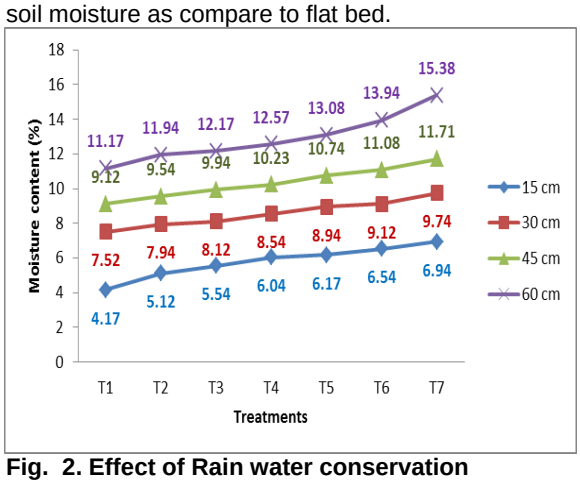

Fig. 2. Effect of Rain water conservation techniques on Moisture Content

Surface Runoff

The seasonal surface runoff recorded in T_1 was maximum (14.59%) followed by T_2 (12.66%), T_3 (2.63), T_4 (0.47%) of the rainfall causing runoff and no runoff recorded in T_5 , T_6 and T_7. 100 per cent reduction in runoff was observed in T_7, T_6 & T_5 followed by T_4 (96.78), T_3 (81.97), T_2 (13.23) over T_1. Sastry (2002) reported that the in-situ rainwater conservation such as compartmental bunding, contour farming and broad bed furrow system conserve the rain water *in-situ* and also reduce soil erosion.

Table 1

Effect of cultivation practices on runoff, soil and nutrient loss

Treatments	T_1	T_2	T_3	T_4	T_5	T_6	T_7

Runoff,%	14.59	12.66	2.63	0.47	-	-	-
Soil loss, t ha^{-1}	2.252	0.778	0.395	0.0782	-	-	-
Nutrient loss (N) $kgha^{-1}$	0.878	0.796	0.702	0.492	-	-	-
Nutrient loss (P) $kgha^{-1}$	0.218	0.156	0.112	0.052	-	-	-
Nutrient loss (K) $kgha^{-1}$	1.154	0.972	0.898	0.610	-	-	-

Soil Loss

During the season maximum soil loss (2.252 t ha^{-1}) recorded in along the slope cultivation (T_1) followed by along the slope cultivation with opening of tied furrow (T_2) (0.778 t ha^{-1}), across the slope cultivation with sub surface tillage (T3) (0.395 t ha^{-1}), across the slope cultivation with opening of alternate furrow with sub surface tillage (T4) (0.0782 t ha^{-1}) and no soil loss recorded in T_7, T_6 and T_5 because of 100 per cent conservation of runoff. Pathak et al. (2013) analyzed the effect of inter-row tillage for improved soil and water conservation on crusted Alfisols. The results revealed that the inter-row tillage in addition to normal intercultivation is found to be effective in controlling the early season runoff and soil loss and increasing crop yields. During the low and medium rainfall years, the additional tillage system is found to be highly effective in reducing runoff and soil loss and increasing crop yields.The 100 per cent reduction in soil loss was observed maximum in the treatment contour cultivation with opening of ridges and furrows (T_7), contour cultivation with opening of alternate furrow (T_6) and across the slope cultivation with opening of ridges and furrow (T_5) followed by across the slope cultivation with opening of alternate furrow with sub surface tillage T_4 (96.5%), across the slope cultivation with sub surface tillage (T_3) (82.5%), along the slope cultivation with opening of tied furrow (T_2) (65.5%) over along the slope cultivation (T_1). Kabango Freddie Rao *et al.* (2000) studied the effect of contour cultivation, deep cultivation, ridges and furrows on runoff and soil loss and *in situ* water conservation. The total run off and soil loss in the control was 9.4% of rainfall (17.2mm) and 1.5 t ha^{-1}, respectively. Runoff and soil loss were reduced significantly by conservation tillage practices compared to sowing along the slope. Payal *et al.*(2001) reported that, between broad bed furrow and ridges and furrow recorded 55.51 % reduction in runoff and 59.77 % in soil loss over control.

Nutrient loss

Data (Table 1) revealed that there is 100 % conservation of nutrient was observed in contour cultivation with opening of ridges and furrows T_7, contour cultivation with opening of alternate furrow T_6 and across the slope cultivation with opening of ridges and furrow T_5 followed by T_4 (44 to 76.2 %), T_3 (20.1 to 48.6 %), T_2 (9.3 to 28.4 %) over T_1. Maximum reduction (100%) in NPK was observed in T_5, T_6, & T_7 followed by T_4, T_3 & T_2 over the T_1. Mandal et al. (2012) studied the nutrient losses by runoff and sediment from an agricultural field. The total runoff recorded was 182, 24, 35, 90 and 10 mm from 787, 292, 385, 331 and 137 mm of runoff producing rainfall events, respectively when corresponding annual rainfall was 1086, 685, 719, 764 and 610 mm during study period. They were noted that erosion process exported significant amounts of nutrients from the field, totalling 20.6 kg C, 5.05 kg N, 0.05 kg P, and 9.94 kg K t^{-1} ha^{-1} yr^{-1} of soil.

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