Effect of Different Land configuration Practices on Productivity of Sorghum – Pigeonpea intercropping system in Shallow Alfisols


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Effect of Different Land configuration Practices on Productivity of Sorghum – Pigeonpea intercropping system in Shallow Alfisols

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ABSTRACT: Soil moisture plays an important role in increasing crop yields in the rainfed Alfisols of semi arid tropics. The effect of land configuration practices on soil moisture content and yield of sorghum – pigeonpea inter cropping system were evaluated during *kharif* seasons of 2006-07 and 2007–08 on shallow Alfisol at Hyderabad. Availability of soil water during different stages of crop growth was increased by ridge – furrow system resulting in increased grain yield of sorghum – pigeonpea intercrops. *In situ* moisture conservation practices viz ridge – furrow and bed – furrows at 0.9 m spacing using tractor drawn furrower tool increased the sorghum grain yield by 29% (3528 kg ha^{-1}) and 17% (3200 kg ha^{-1}) during 2006 -07 and 36% (3210 kg ha^{-1}) and 27% (2992 kg ha^{-1}) during 2007-08 respectively over no furrows. Ridge – furrow practice improved sorghum equivalent yield to an extent of 21 and 55% in 2006-07 and 2007-08 respectively.

Key words : Consrvation, soil moisture, sorghum, pigeonpea, intercrops

Conservation and judicious use of natural resources like soil and water play an important role in sustainable crop production under rainfed farming in semi – arid tropics. In, India there is a very limited scope for increasing area under crop production to meet the food and fodder requirements of increasing human population and existing animal heads. The only solution is to increase the crop productivity per unit area in a unit time. This can be achieved through scientific management of soil and water resources.

In semi-arid tropics, alfisols constitute about 33% of the area (Kampen and Burford, 1980). In India, Alfisols occupy about 20% of the rainfed regions covering 59.6 x 10^6 hectares and are located mostly in south India (Venkateswarlu, 1987; Singh,1995). These soils are shallow, coarse textured, contain low organic matter and are prone to sever erosion. Crop yields are low partly due to dry climate, shallow depth of soils and low moisture holding capacity. The soils are often subjected to high intensity rain storms of short duration causing excessive run–off in the *kharif* season crop growth period (May to September). In this type of soils, as much as 25% of the annual rainfall could be expected as run-off (Kanwar, 1982).

Different land configuration practices (Conservation practices) such as Contour cultivation, ridge and furrow, bed and furrow and open furrow in between crop rows are recommended for reducing run-off and to increase the soil moisture content. An experiment at Central Research Institute for Dryland Agriculture, India recorded 50–60% run-off reduction under simulated conditions in semi-arid cultivable lands having ridges and furrow across the slope when compared with no conservation practice (Mishra *et al,* 2006). In an other study, it was observed that, the final infiltration rates were increased as the stone cover percent increased on Alfisol soil surface under artificial rainfall simulated conditions (Mandal *et al,* 2005). The effects of above said land configuration practices on yield of different crops are well documented under semi-arid Vertisols and under irrigated crop conditions. However, there is no systematically conducted field studies in shallow Alfisols of semi-arid tropics. More over, the farmers in south India, where the Alfisols are predominant clean cultivation is followed in seasonal crops. Lack of proper vegetation in the initial crop growth period leads to excess run-off from the fields. This indicates the need for a field study to quantify the rain water conserved in the root zone depth and its effect on crop growth and yields.

The spacing required in conservation practices also depends on crop row spacing which is also an additional factor in controlling runoff. Hence, the relationship between furrow dimensions and spacing require proper investigation under field conditions.

Based on this overview of the conditions in southern Telangana zone of Andhra Pradesh, India, the present field study was carried to investigate the effect of different furrow configurations and spacing on soil moisture conservation and yield of Sorghum + Pigeonpea intercropping system in rainy season.

Materials and Methods

Soil and site characteristics

An experimental site was selected on a medium textured red Alfisol at Hayatnagar Research Fram of Central Research Institute for Dryland Agriculture, Hyderabad situated in southern dry zone of Telangana of Andhra Pradesh state, India at 17^0 20 N latitude, 78^0 42 E longitude and 515 m above mean sea level. Farm situation represents semi–arid tropical environment with hot summer and mild winter. The experiment was conducted during the rainy seasons of 2006 and 2007. Selected physical and chemical properties of the soil are presented in Table 1 and Table 2. During the previous rainy season (*Kharif*) of 2005, castor bean (*Ricinus communis*) was grown at the experimental site with recommended fertilizer and plant protection practices. Crops were grown completely under rainfed situations and no supplemental irrigation was applied. Mean annual rainfall is 739.8 mm and accounts for approximately

Table 1: General physical characteristics of the Alfisol soil at experimental site

Soil Properties	Value	Method
Mechanical Analysis (0 - 0.4m, Per cent)		International pipette method (Piper, 1966)
Sand	65 ± 2.3	
Silt	3.41 ± 0.7	
Clay	31.53 ± 2.0	
Infiltration rate (mm/h)	6.72 ± 0.66	Double ring infiltrometer method (Black, 1965)
Bulk density (g/cc)		Core sampler method (Black, 1965)
0 – 0.10 m	1.54 ± 0.03	
0.10 – 0.20 m	1.39 ± 0.03	
0.20 – 0.30 m	1.39 ± 0.03	

The values in the table are Mean ± SEm

Table 2: General chemical characteristics of the Alfisol soil at experimental site

Soil Properties	Soil depth		Method
	0 – 0.2 m	0.2 – 0.4 m	
Soil p^H	7.2 ± 0.30	6.7 ± 0.17	p^H meter (Piper, 1966)
EC (ds /m)	0.058 ± 0.007	0.047 ± 0.013	Conductivity bridge
Available N (kg/ha)	137.5 ± 5.84	135.3 ± 6.0	Alkaline permanganate method (Subbaiah and Asija, 1956)
Available P (kg/ha)	10.83 ± 2.34	6.96 ± 0.97	Oslen's method (Jackson, 1967)
Available K (kg/ha)	241.17 ± 13.94	159.1 ± 22.5	Flame photometer (Muhr *et al,* 1965)
Organic carbon (kg/ha)	0.41 ± 0.04	0.51 ± 0.07	Wet oxidation method (Piper, 1966)

The values in the table are Mean ± SEm

42% of potential evapotranspiration. Nearly 70% of the total rainfall is received during the southwest monsoon season (June to September).

Treatments

The field experiment was laid out with five conservation measures using two types of furrow making Implements. Before imposition of treatments, the experimental field was tilled with tractor drawn cultivator twice and followed by disc harrow twice after onset of rainfall during monsoon. On the well prepared seed bed, the following six treatments were imposed.

- T_1 - Control (No Furrow).
- T_2 - Ridge and furrow with tractor drawn furrow maker.
- T_3 - Conservation furrows at 0.9 m spacing with country plough.
- T_4 - Bed-furrows at 0.9 m spacing using tractor drawn furrower.
- T_5 - Conservation furrows at 1.35 m spacing with country plough.
- T_6 - Bed-furrows at 1.35 m spacing using tractor drawn furrower.

The furrow spacing 0.9 and 1.35 m was choosen with a view that, on 0.9 m furrows spaced bed two rows of 0.45 m row spacing crops and on 1.35 m furrows spaced bed three rows of 0.45 m row spacing crops or two rows of 0.90 m row spacing crops could be drilled using existing tractor drawn seed drills with fewer adjustments. For majority of cereals, oil seed and pulse crops grown in rainfed conditions of India, the furrows spacing 0.9 and 1.35 m are more convenient.

Sorghum + Pigeonpea inter cropping system in 2:1 ratio at 45 cm row spacing was sown in first half of June month in both the years using a tractor drawn seed drill fitted with three narrow width furrow openers. The tractor was fitted with a narrow width tyres and track spacing was adjusted suitably to avoid disturbance to the furrows made in the above described treatments. Sorghum (*Sorghum biocolar* L.Moench) (SPV1616) and Pigeonpea (*Cajanus cajan*)(PRG 100) crops were the test crops in the study. The experiment was laid out in a strip plot completely randomized design with three replications on land having 1.0 % slope.

Weeds were controlled manually. After 20 days of crop sowing, the furrow was reshaped using respective implements. The moisture content of soil profile was measured using deviner 2000 instruments at 0 – 0.10, 0.10 – 0.20, 0.20 – 0.30 and 0.30 – 0.40 m soil depth in all six treatments of all four replications at sowing, 25, 50, 75 and 100 days after sowing (DAS) and the values were converted into mm water content of 0.4 m profile depth using standard procedure. Grain and straw yields from experimental plots were harvested, sun dried, weighed and converted on hectare basis. The daily rainfall was measured by using standard ISI rain gauge located in class 'A' metrological observatory situated about 300 m from the experimental plot at the research station. Slight run-off was observed from some of the experimental plots during the crop growth period.

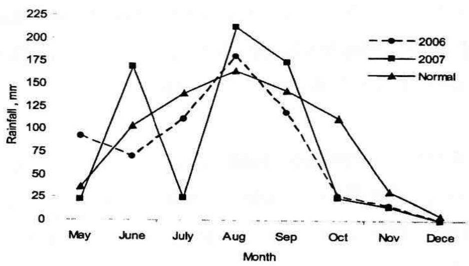
Statistical analysis

The data were analyzed using a computerized statistical 'DRYSOFT – C' package (Gomez and Gomez, 1985). Probabilities less than 0.05 were considered significant. When analysis of variance indicated significant difference, the LSD test was used to separate the treatment means of conservation practices for comparison across them and presented in the tables and text.

Results and Discussion

Rainfall: During crop growth period 2006 – 07 and 2007 – 08 , the rainfall of 528.8 and 633.8 mm received was 79.4 and 95% of mean rainfall of 665.9 mm.The mean of past 38 years rainfall is presented in Fig.1 along with the 2006 and 2007 data. During 2006, only 69 mm rainfall occurred in June against the mean of 98 mm, resulting in moisture stress during initial growth stage of the crop for a period of 20 days.In the year 2007, the rainfall is considerably higher in June, August and September, on par in October and November and less in the month of July. Crop season rainfall of 633.8 mm during 2007 - 08 was 20% higher compared to 528.8 mm in the first year of the study (2006 – 07).The rainy days during the crop growth period were 52 and 66 days respectively for 2006 – 07 and 2007 – 08.

Fig 1. Monthly mean Rainfall during Crop growth period



Conservation measures and soil moisture storage

The furrows formed using the tractor drawn furrower were wider and deeper when compared with the furrows made with bullock drawn country plough irrespective of the furrows spacing. The furrows were trapezoidal in shape with a bottom width of 5.3 and 2.4 cm for tractor drawn tool and country plough respectively. The furrow top width formed with the tractor drawn tool was 2.2 times wider and 41% more deeper when compared with country plough (Table 3). The furrower tool developed is easily operated as a tractor drawn tool in 45 cm crop row spacing using a tractor fitted with narrow tyres of 8-3-32 inches size upto 30 - 35 days of crop growth period. Beyond this, crop damage was observed, if operated to reshape the furrows. The furrows formed using both the tools progressively become narrow in width and shallow in depth as the rainy days increased. The furrows formed using country plough irrespective of their spacing almost vanished by the end of crop harvesting stage of sorghum, on the other hand furrows formed with tractor drawn furrower tool transformed into shallow depth crescent shaped depression but were still clearly visible even after sorghum crop harvesting.

Ridge and furrow followed by furrows made using tractor drawn furrower at 0.9m spacing consistently recorded higher amount of soil water from sowing to harvesting in top 0.4m soil depth as compared to other measures during both the years of study (Table 4). The control treatment with out furrows recorded lowest soil water content at any given time. It was clear from the above results (mean values) that, the furrows might increased the time to runoff initiation (time to runoff is the minimum time required to accumulate the rain water on soil surface to initiate runoff from a given field due to rainfall).With a higher time to runoff initiation, there is more opportunity

Table 3: Furrow dimensions formed using different tools

Parameter	Tractor drawn Furrow maker with 20 cm wing width	Country Plough
Furrow top width (cm)	36.44 ± 0.94	16.5 ± 0.29
Furrow bottom width (cm)	5.3± 0.37	2.4 ± 0.2
Furrow depth (cm)	16.11 ± 0.42	11.4 ± 0.27

The values in the table are Mean ± SEm

Table 4: Soil moisture in top 0.4 m soil profile as influenced by moisture conservation measures

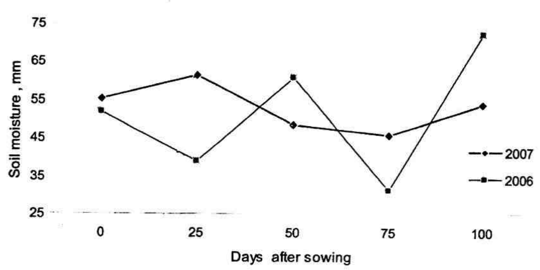
Treatment	Soil moisture (mm) in top 0.4 m soil profile									
	2006					2007				
	At sowing	25 DAS	50 DAS	75 DAS	100 DAS	At sowing	25 DAS	50 DAS	75 DAS	100 DAS
T_1	48.7	30.8	51.9	24.9	60.1	47.5	52.5	39.4	38.8	44.7
T_2	65.0	49.9	82.6	31.5	79.9	69.6	82.7	58.6	53.3	62.4
T_3	46.6	38.6	55.6	26.5	74.4	52.3	56.2	48.1	44.7	54.0
T_4	53.6	48.1	59.9	27.9	76.4	62.5	60.8	52.0	55.0	56.1
T_5	52.1	35.2	55.6	36.3	67.2	55.3	56.5	46.0	47.0	53.8
T_6	44.8	31.3	58.6	39.3	74.1	44.7	59.8	47.0	36.1	51.5

DAS = Days after sowing

time for infiltration and better moisture conservation in the soil profile. Forming or opening of furrows at different crop row spacing increased the profile soil moisture content by arresting runoff of rainfall received. As the furrow spacing of conservation measures increased, the profile moisture content decreased. However, decrease in the moisture content was not significant statistically. The similar trend was observed under rainfall simulated conditions in the shallow Alfisols of south India by Mishra *et al,*(2008).

The mean soil water content in top 0.4 m profile at different growth stages is presented in Fig.2.Though, in both the years the conservation practices implemented were similar, but during the crop season in 2007, the conservation measures conserved higher amount of soil water in root zone depth as compared to the previous year (2006). Higher soil water content in 2007 was attributed to more rainy days and higher quantity of rainfall. It is clear from the Fig.2 (mean values) that the profile moisture measured narrowly varied from 46 to 55mm in 2007 and widely ranged from 31 to 72 in the year 2006.

Fig 2. Soil moisture status in top 0.4 m profile during crop growth period.



Grain and stover yield

The conservation practices significantly influenced the growth, yield attributes and yield of kharif sorghum + pigeonpea inter cropping system in 2007-08 but during 2006-07, the significant influence was observed in case of pigeonpea only (Table 4). The increase in sorghum grain yield due to ridge-furrow conservation measure (T_2) during 2006-07 and 2007-08 were to the extent of 29 and 36% respectively over farmers practice (Control). In absolute terms, these yield levels were 3528 and 3210 kgha^{-1} during the years 2006-07 and 2007-08 respectively. In case of bed-furrows at 0.9 m spacing using tractor drawn furrower (T_4) the grain yield level was 3200 and 2992 kgha^{-1} during 2006-07 and 2007-08 and were higher by 17 and 27% respectively over control.

The pigeonpea yield in 2006-07 was erratic, decreased considerably when compared to normal yields. This may be due to the fact that, the crop experienced soil water deficit in early growth stage (Table 4), as a result, the pigeonpea plant population reduced in the experimental plots. During subsequent rains, the sorghum recovered quickly and dominated throughout the rest of the growing period. Because of this reason, the sorghum grain and stover yields were higher when compared to 2007-08, even though number of rainy days and total quantum of rainfall were lower. In 2007-08 cropping season, the pigeonpea yields followed the trend of sorghum. Ridge and furrow, conservation furrows opened at 0.9 m spacing using tractor drawn tool recorded 764 and 755 kgha^{-1} respectively, when compared with control practice (no furrows) which yielded 410 kgha^{-1}. In 2007-08, the profile moisture contents were more or less maintained within the available moisture range at various critical growth stages of crop in all the treatments, which resulted in improvement in over all sorghum equivalent yields. The trend in stover yield was also similar to that of grain yields in ridge and furrow, furrows at 0.9 m spacing, furrows at 1.35 m spacing and no furrows (Control). Higher grain and stover yields observed in ridge-furrow, furrows opened at 0.9 m spacing using tractor drawn tool as compared to furrows at 1.35 m spacing and control was attributable to higher soil water content in top 0.4 m soil profile at different stages of crop growth and at harvest during both the years of study (Table 4 and Fig.2).

Greater soil water in top 0.4 m soil profile in ridge and furrow (T_2), bed-furrows at 0.9 m spacing using tractor drawn furrower(T_4) and bed-furrows at 1.35 m spacing using tractor drawn furrower(T_6) plots was attributable to the formation of miniature bunds restricting the lateral flow of rain water and increased the time of infiltration as a result of reduced runoff and soil loss and increased infiltration rate. The findings of present studies are in accordance with those of Surkod (1993). The corresponding yield levels during 2006-07 and 2007-08 with farmers practice (control) were 2735 and 2347 kg ha^{-1}.

Table 5: Grain yield of Sorghum + Pigeonpea as influenced by different conservation measures

Treatment	Grain yields, kg ha^{-1}					
	2006 - 07			2007 - 08		
	Sorghum	Pigeonpea	S.E. Yield	Sorghum	Pigeonpea	S.E. Yield
T_1	2735	139	3194	2347	410	811
T_2	3528	77	3860	3210	762	5927
T_3	3074	120	3471	2847	654	5178
T_4	3200	54	3380	2992	755	5656
T_5	3186	56	3373	2824	598	4959
T_6	3227	60	3408	2929	722	5506
S.EM±	236	9		126	13	123
LSD (P =0.05)	NS	21	NS	333	35	326

S.E = Sorghum equivalent yield S.E.M± = Standard error mean LSD = Least significant difference
NS = Non significant

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