Original Research Article

Role of Moisture Conservation Methods in Rainfed Cropping Systems of Telangana State

ABSTRACT

The study was conducted with an objective of assessing best practice of moisture conservation and profitability of the cropping system. The experiment was executed at Agricultural Research Station, Tornala, Siddipet (Dt), Telangana State for three years (*kharif,* 2016 -*kharif*, 2018). The trial was laid out in split plot design with three cropping systems as main plots *Viz*., sole maize (SM), maize + pigeon pea in 4: 1ratio (MP) and sole pigeon pea (SP) and three sub plots were allotted with moisture conservation practices viz., ridge and furrow (RF), flatbed followed by making ridge at 25DAS (FBR) and flatbed followed by making conservation furrow at 25 DAS (FBCF) along with regular farmers practice,flatbed method (FB).The results revealed that, among different cropping systems sole pigeon pea (SP) recorded significantly higher maize equivalent yields and net returns (4340 kg $ha^{-1}$and Rs.33926 ha^{-1})compared to sole maize (SM) (3268 kg $ha^{-1}$and Rs.15366 ha^{-1}) and maize+ pigeon pea intercropping in1:4ratio (MP) (4080 kg $ha^{-1}$and Rs.25786 ha^{-1}), whereas in case of moisture conservation methodsridge and furrow method (RF) recorded significantly higher maize equivalent yields in kg ha^{-1} (4253 kg $ha^{-1}$and Rs.26752 ha^{-1}) followed by flatbed fb making conservation furrow at 25 DAS (FBCF) (4247 kg $ha^{-1}$and Rs.30,042 ha^{-1}) compared flatbed fb making ridges at 25 DAS (FBR) and flat bed. Ridge and furrow method could save more (26%) soil moisture among all the methods followed in the study.

Key words: Maize, pigeon pea, rainfed cropping system, moisture conservation, equivalent yields

1. INTRODUCTION

India ranks first with respect to area (86 M.ha) of rainfed agriculture in the world.In India, 40% of the food grainsproduced under rainfed condition only. Sowing of single crop under rainfed cultivation is unpredictable situation for the farmers.To solve this, intercropping is recommended as it has greater yield advantage and substantially increases in net returns, especially under adverse weather conditions (Barhom *et al*., 2001, Chen et al., 2004 and Tsubo*et al*., 2005). The farmers of Siddipet district adopted intercropping practice of maize and pigeon pea at ratio of 4:1 in rainfedAlfisols asmaize (*Zea mays* L.) and Pigeon pea (*Cajanuscajan* L.) are two important crops of rainfedAlfisols of Telangana State.

The study was conducted at Agriculture Research Station, Tornala. It is a newly established station in Siddipet district of Telangana State.The station comes under Central Telangana Zone. It consists of sandy loam soils and most of farmers are practicing rainfed farming. The majorly cultivated crops in the area are pigeon pea and maize.Being low rainfall area,it is characterized by frequent dryspellsand it leads to frequent crop failure. In rainfed farming establishing a crop is major constraint due to lack of adequate moisture in the seed zone. After germination, dry spells of two weeks or more resulting in moisture stress conditions leading to decline in productivity and may also sometimes causes total crop failure. Therefore, for the sustainable production the area requires adoption of location specific in-situ soil moisture conservation technologies. Taking this into consideration, the present study was planned for three years (*kharif*, 2016-*kharif*, 2018) by cultivating different cropping systems along with moisture practices to assess the best practice of conservation of moisture and profitability of the cropping system under rain fed conditions of Siddipet (Dt).

Pigeon pea is a staple and protein rich food. Since, it has deep rooted system, it is resistant to drought and suitable for dryland farming(Saroj*et al*., 2013). It ishaving an area of 3.5m.ha with a production of 2.5 m.mt and productivity of 813 $kgha^{-1}$(ICAR- IIPR, 2018-19) in the country. In Telangana state, it is grown with an area of 2.9 lakh.ha, 2.6 m.tonnesof production andproductivity of 912 $kgha^{-1}$. Intercropping with more rapidly growing crops like maize to utilize the natural resources more efficiently due to its slow growing nature in the earlystages facilitates(Vijayaprabhakar*et al.,* 2018). Maize (*Zea mays L*.) is one of the promising cereals cultivated in India. Itis a versatile crop adapted to various agro-climatic regions.In India, it is cultivated in an area of 9.03 m.ha with 27.72 m.t production and productivity of 3070 kg ha^{-1}. Telangana state is having 6.3 lakh hectaresof maize area with a production of 36.4m.t and productivity of 5730 kg ha^{-1}

[1](CMIE, 2018-19).Siddipet district stands at second position in-terms of production (2.6 lakh tonnes) in Telangana state.

2.Material and Methods

2.1. Salient soil characteristics of experimental site

The soil of experimental field was sandy clay loam in texture. The composite soil sample prior to experimentation was collected from 0-15 cm and the sample was air dried and sieved through 2 mm sieve and was analysed for physical and chemical properties by following standard analytical methods.

Table.1 Soil characteristics of experimental site.

S.No.	Name of the soil property	Value
I.	**Physical properties**	
a)	Textural fraction	
	1) Sand (%)	64.6
	2) Silt (%)	12.6
	3) Clay (%)	22.8
b)	Textural class	Sandy clay loam
II.	**Physico-chemical analysis**	
a)	Soil reaction (pH)	6.9 (Neutral)
b)	Electrical conductivity (dSm^{-1})	0.03(Normal)
III.	**Chemical properties**	
a)	Organic carbon (%)	0.45 (Low)
b)	Available Nitrogen (kg ha^{-1})	184 (Low)
c)	Available phosphorus (kg P_2O_5 ha^{-1})	27.5 (Medium)
d)	Available potassium (kg K_2O ha^{-1})	202 (Medium)

2.1 Details of planting

The field trial was conducted at 'c' block of Agriculture Research Station, Tornala, Siddipet district, Telangana State for three years during *kharif*, 2016 to *kharif*, 2018. The experimental trial was laid out in a split plot design with three main plots as cropping systems viz., sole maize (SM), maize + pigeon pea in 4:1 ratio (MP) and sole pigeon pea (SP) and four moisture conservation practices as sub plots *Viz*., flatbed method (FB), ridge and furrow sowing (RF), flatbed method followed by making ridges at 25 DAS (FBR) and flatbed method followed by conservation furrow at 3 m interval (between 5^{th} and 6^{th} row) (FBCF) were replicated thrice using maize hybrid (DHM-117) and pigeon pea (PRG-176) which are popular in Telangana state. The plot size and spacing followed is 6 m X 4 m and 60 cm x 20 cm. All the agronomic practices were followed as per the recommendations of PJTASU.

3.Result and Discussion

The total agriculture area in India is almost 60 % under rainfed condition only. The most of the future food needs of the country has to be accomplished from rainfed farming (Kanwar, 2000). Now-a-days intercropping is becoming popular under rainfed farming because of yield advantage, especially under adverse weather condition and substantially increases economic returns. Maize and pigeon pea differs in growth habit and duration which increase complementary effects in space leading to more efficient use of growth resources (Kamanga*et al*., 2010 and Patra*et al*., 2000).

In rainfed regions amount and distribution of rainfall play a significant role in determining the crop growth as well as production. However, the distribution of rainfall is more important than total amount received in a season (Rao et al., 2010).Table 2 showed thatduring the crop growth period *i.ekharif*, 2016-*kharif*,2018 (July to December) a total rainfall of 809.3 mm was received in 49 rainy days as against the normal rainfall of 787.6 mm and depicted as excess of rainfall 6.6 % was received in entire cropping season.

The crop was sown in first fortnight of July and showing deficitof 40% rainfall in July month. In total, the crop experienced two dry spells of 12 and 54 days during vegetative (52-64 DAS) and flowering to maturity (80-134 DAS) respectively. The growth and yield of the pigeon pea and maize crops were drastically reduced due to dry spells during critical stages. Hence the yield obtained in this experiment was low as compared to normal rainfed corn yields.

Table.2 Distribution of rainfall during the crop period (Mean of *kharif,* 2016 – *kharif*,2018).

S.No.	Month	Actual Rainfall (mm)	Normal Rainfall (mm)	Deviation (%)
1	July	128.1	213	-40
2	August	222.9	184.6	+21
3	September	99.6	98.7	+1
South west monsoon		**450.6**	**496.3**	**-9**
4	October	254.1	89.2	+185
5	November	18.2	28.2	-35
6	December	0.0	5.2	-100
North east monsoon		**272.3**	**122.6**	**+122**
Total		**722.8**	**787.6**	**-8**

Table.3Maize equivalent yield (Kg ha -1) (*Kharif*, 2016 to *Kharif*,2018)

Main/sub	SM	MP	SP	Mean
FB	2677	3056	3211	2981
RF	3451	4539	4768	4253
FBR	3614	4274	4691	4193
FBCF	3601	4451	4689	4247
Mean	3268	4080	4340	

SM: Sole maize; MP: Mize + pigeon pea in 4:1 ratio; SP: Dole pigeon pea; FB: Flatbed method; RF: Ridge and furrow sowing; FBR: Flatbed method followed by making ridges at 25 DAS; FBCF: Flatbed method followed by conservation furrow at 3 m interval (between 5th and 6th row).

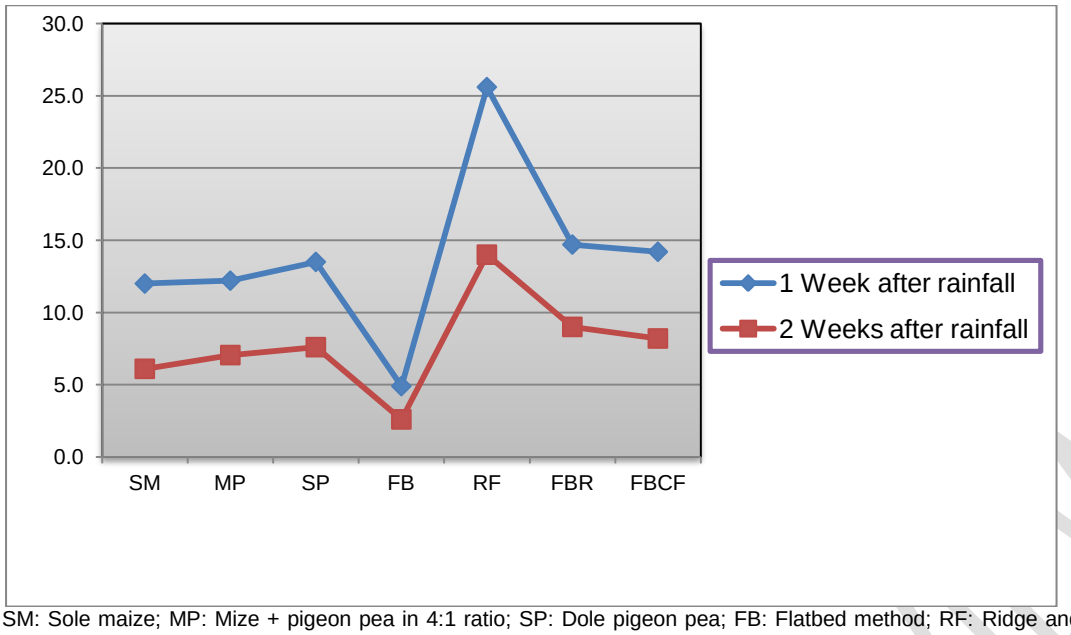
	SEm(±)	CD(*P=0.05%*)
Main plot	44	171
Sub plot	51	108
Factor B at same level of A	89	210
Factor A at same level of B	99	234

Table.4Effect of moisture conservation methods and cropping systemsin rainfed conditions on economics (Mean of *kharif*, 2016-*kharif*,2018)

Treatments	Cost of cultivation (Rs ha^{-1})	Gross returns (Rs ha^{-1})	Net returns (Rs ha^{-1})	Benefit cost ratio
Main plots-Cropping systems				
SM	33971	49337	15366	1.45
MP	35823	61609	25786	1.72
SP	31606	65532	33926	2.07
Sub plots- Moisture conservation practices				
FB	31767	45018	13251	1.42
RF	34461	64213	29752	1.86
FBR	34372	61940	27568	1.80
FBCF	34090	64132	30042	1.88

SM: Sole maize; MP: Mize + pigeon pea in 4:1 ratio; SP: Dole pigeon pea; FB: Flatbed method; RF: Ridge and furrow sowing; FBR: Flatbed method followed by making ridges at 25 DAS; FBCF: Flatbed method followed by conservation furrow at 3 m interval (between 5th and 6th row).

Figure.1Soil moisture content (%) as influenced by moisture conservation practices



SM: Sole maize; MP: Mize + pigeon pea in 4:1 ratio; SP: Dole pigeon pea; FB: Flatbed method; RF: Ridge and furrow sowing; FBR: Flatbed method followed by making ridges at 25 DAS; FBCF: Flatbed method followed by conservation furrow at 3 m interval (between 5th and 6th row).

3.1 Soil moisture content (%)as influenced by moisture conservation methods:

The study (figure. 1) revealed that, among the different cropping systems, higher soil moisture content (8% and 13%) was observed in sole pigeon pea,whereas in case of moisture conservation method, ridge and furrow recorded more soil moisture content (14% and 26%).The ridge and furrow methodsupported in conservation of rain water and its availability for longer duration and acts also acted as aminibarriers in preventing the run-off water. Hence, ridges and furrow method helped in improving moisture and nutrients availability as well as nutrient uptake. This result is in conformity with that ofBhople*et al*., 2018.

3.2 Effect of moisture conservation methods and cropping systemsin rainfed conditions onmaize equivalent yield (Kg ha^{-1}):

The data furnished in table 3 indicated that significantly higher maize equivalent yield was obtained in sole pigeon pea cropping system (4340 $kgha^{-1}$) followed by maize + pigeon pea intercropping (4:1) (4080 $kgha^{-1}$)and sole maize (3268 kg ha^{-1}). Whereas, among the moisture conservation methods higher maize equivalent yield was recorded by ridge and furrow method (4253 $kgha^{-1,}$) followed by flatbed fb making conservation furrow at 25 DAS (4247 $kgha^{-1}$), flatbed fb making ridge at 25DAS (4193 $kgha^{-1}$) and flat bed (2981 kg ha^{-1}).Rana et al., (2001) also expressed similar views on yield.The higher soil moisture retention (14%) even two weeks after rainfall also helped the crop in securinghigher productivity in sole pigeon pea where as the lower soil moisture retention (3%) in maize is reflected by significantly lower yields.

3.3 Effect of moisture conservation methods and cropping systemsin rainfed conditions on economics (Kg ha^{-1}):

With regard to economics, table 4 indicated that sole pigeon pea recorded higher gross returns (Rs.655532 ha^{-1}), net returns (Rs.33926 ha^{-1}) and B:C ratio (2.07) followed by maize + pigeon pea intercropping (4:1) (Rs.61609 ha^{-1}, Rs.25786 ha^{-1} and 1.72) and sole maize (Rs.49337 ha^{-1}, Rs.15366 ha^{-1} and 1.45).While, in case of moisture conservation practices,flatbed fb making conservation furrow at 25 DAS observed with higher gross, net returns and B: C ratio (Rs.64132 ha^{-1}, Rs.30042 ha^{-1} and 1.88) followed by ridge and furrow method (Rs.64213 ha^{-1}, Rs.29752 ha^{-1} and 1.86), flatbed fb making ridge at 25DAS (Rs.61940 ha^{-1}, Rs.27568 ha^{-1} and 1.80) and Flat bed (Rs.45018 ha^{-1}, Rs.13251 and 1.42). Higher maize equivalent yield (4253 kg ha^{-1}) in ridge and furrow method lead to higher gross returns, net returns and benefit cost ratio.

4.CONCLUSION AND RECOMMENDATION

From the study, it could be concluded that sole pigeon pea can be recommended under rainfed conditions of Siddipet (Dt.) of Telangana State to obtain higher yields and net returns compared to traditional cropping systems like sole maize and maize + pigeon pea intercropping in 4: 1 ratio. For moisture conservation,based on farmer convenienceeither ridge and furrow orflatbed fb making conservation furrow at 25 DAS can be adopted.

5.References

Annual report, ICAR- Indian Institute of Pulse Research, 2017-18.

Barhom TIH. Studies on water requirements for some crops under different cropping systems. M.Sc. Thesis, Facility of Agriculture, Cairo University. 2001.

BeedyTL, Snapp SS, Akinnifesi FK, Sileshi GW. Impact of *Gliricidiasepium* intercropping on soil organic matter fractions in amaize-based cropping system. Agriculture- Ecosystem and Environment. 2010;138(4):139-146.

Bhople KJ. Kubde, Bharti T, Godavari G. Impact of land configurations and nutrient levels on growth and yield of sunflower under rainfed condition. International Journal of Current Microbiology and Applied Sciences. 2018;7(01): 363-368.

ChenC, Westcott M, Neill K, Wichman D, Knox M.Row configuration and nitrogen application for barley-pea intercropping inMontana. Agronomy Journal. 2004;96:1730-1738.

Francis CA, Biological efficiency in multiple cropping systems. Advances in Agronomy.1989;42:1-42.

Kamanga BCG, Waddington SR, Robertson MJ, Giller KE. Risk analysis of maize-legume crop combinations with smallholder farmers varying in resource endowment in central Malawi. Experimental Agriculture. 2010;46(1):1-21.

Kanwar JS, 2000. Soil and water resource management for sustainable agriculture imperatives for India. In: "International Conference on Managing Natural Resources for Sustainable Agricultural Production in the 21st Century". Water Technology Centre and Indian Agricultural Research Institute, New Delhi,India, 2000.

Lynam JK, Sanders, Mason SC. Economics and risk in multiple cropping. In: Multiple Cropping Systems, Francis, C.A. (Ed.). Macmillan, New York. 1986;250-266.

Meena VS, Sharma S,Dagar V. Production and growth in pulses in India. Agricultural Situation in India. 2016.

Patra BC, Mandal BK, Padhi AK. Production potential of winter maize (*Zea mays*) – based intercropping systems. Indian Journal Agricultural Sciences. 2000;70(4):203-206.

Singh VK,Bajpai RP. Intercropping in maize (Zea mays) under rainfed condition. Indian Journal of Agronomy.1991;36(3):398-399.

Singh M, Singh, RK. Prospects of growing pulses under multiple and intercropping. Indian Journal of Genetics and Plant Breeding.1975;35 (2): 216-219.

Rana, R.S, Singh, B, Negi, S.C, Singh, B. Management of maize/legume intercropping under mid-hill sub-humid conditions. Indian Journal of *Agricultural* Research.2001;35:100-103.

SarojSK, Singh MN, Kumar R, Sign T, Singh MK. Genetic variability, correlation and path analysis for yield attributes in Pigeonpea. The Bioscan.2013;8(3): 941-944.

Rao, GSLHVP, Rao, GGSN., Rao VUM. Climate Change and Agriculture over India. PHI Learning Private Limited, New Delhi. 2010;328.

Tsubo M, Walker S, Ogindo HO. A simulation model of cereal-legumeintercropping systems for semi-arid regions II. Modelapplication. Field Crops Research. 2005;93:23-33.

Vijayaprabhakar A, Jayanthi C, Balusamy, M, Malarvizhi P,Chandrasekhar CN. Effect of land configurations and intercropping on plant height andbiomass accumulation of redgram under rainfed ecosystem.International Journal of Current Microbiology and Applied Sciences.2018;7(7): 2471-2477.

Pic1 Sowing in flatbed

Pic 2 **Sole maize crop sown in flat bed method**

Pic 3 SoleMaize crop sown in ridge and furrow method

Pic 4 Sole maize crop sown in flatbed fb making ridges at 25 DAS

Pic 5 Sole maize crop sown in flatbed fb making conservation furrow at 25 DAS

Pic 6 Sole pigeon pea sown in flat bed method

Pic 7 Sole Pigeon pea sown on flatbed fb making conservation furrow at 25 DAS

Pic 8 Sole Pigeon pea sown in ridge and furrow method

Pic 9 Maize + pigeon pea at 1:4 ratio sown in ridge and furrow method

Maize + pigeon pea at 1:4 ratio sown in flatbed fb making conservation furrow at 25 DADS

Pic 10 Maize at harvesting stage in Maize + pigeon pea at 1:4 ratio **Pigeon pea after harvesting of maize in Maize + pigeon pea at 1:4 ratio**

Pic 11 Water conservation in ridge and furrow method