

Original Research Article

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Influence of Set Row Cultivation on Pearl millet-Sunflower Sequence Cropping System in Vertic-Inceptisol

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ABSTRACT

Keywords

Set row cultivation, Pearl millet, sunflower cropping sequence, tank silt and microorganisms

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A field experiment was carried out at to study the impact of set row cultivation on pearl millet – sunflower crop sequence productivity and microbial population at AICRP on Dry land Agriculture, Regional Agricultural Research Station, Vijayapura, Karnataka during three consecutive *kharif* and *rabi* season. The pooled data indicated that, application of tank silt + crop residue in set furrows with paired row spacing (45-135-45 cm) recorded significantly higher pearl millet grain yield (1737 kg/ha) over rest of the treatments. However, it was on par with the treatment receiving tank silt + crop residue in set furrows either with wider row (135 cm) or paired row planting techniques (45-90-45 cm). In succeeding sunflower crop recorded higher sunflower yield (717 kg/ha) with application of tank silt + crop residue in set furrows with wider row spacing (135 cm) followed by tank silt + crop residue in set furrows with paired row planting of 45-90-45 cm and 45-135-45 cm (674 and 694 kg/ha, respectively) and were significantly higher over farmers practice (312 kg/ha). Similarly, considerable improvement in the population of soil micro-organisms was noticed. Application of tank silt and respective crop residues in set furrows with different planting patterns showed significantly higher population in bacteria, fungi, Actinomycetes, Azotobacter, PSB and Fluorescent Pseudomonas.

Introduction

Improvement in dry land agriculture holds the key to sustainable food and livelihood security for majority of the population in the country. The new paradigm for dryland agriculture calls for concurrent attention to the principles of ecology, economics, equity and environment.

Unscientific land and crop management practices have resulted in loss of nearly 6000 million tons of top fertile soil (16 t/ha/year) through erosion every year causing soil degradation in India. In Northern dry zone of Karnataka, occurrence of high runoff (20 to

40 % of annual rainfall), soil loss (12 to 43 t/ha/year) and nutrient loss (48 kg N, 16 kg P₂O₅ and 27 kg K₂O/ha) is a common feature (Guled *et. al.*, 2003). Under dry land conditions adoption of appropriate soil and water conservation technique help to reduce runoff by 65 to 70 per cent and soil loss by 67 to 70 per cent. By adopting appropriate terrace level practices, soil loss and runoff can be minimized because these practices modify the land slope to desired grade when bunds are put at recommended vertical interval. On the other hand, adoption of suitable interterrace land management practices are

known to minimize the soil loss, runoff and nutrient loss. Consequently, both the practices help in sustaining the higher yield level of crops, besides conserving the valuable soil and rainwater resources.

Set row cultivation is one of the *in-situ* moisture conservation practices. This system is widely followed by the farmers of Sourashtra region of Gujarat, where cultivation of crops in the wider rows, which are set permanently over long period in the dryland areas for higher crop productivity, is in practice.

It conserves rainwater effectively, improve the fertility of soil in set furrows and this technique offers an excellent drought proofing mechanism. Infiltration rate is increased effectively by reducing the runoff and soil loss. This practice will be able to provide the soil moisture at critical growth stages of the crops. Set row cultivation also improves soil physico-chemical and biological properties (Mishra, 2002).

Materials and Methods

A field experiment was conducted during three consecutive *kharif* and *rabi* season of 2004 – 05, 2005 – 06 and 2006 – 07 on a fixed site to study the effect of set furrows on pearl millet – sunflower crop productivity and microbial population at AICRP on Dryland Agriculture, Regional Agricultural Research Station, Vijayapura, Karnataka. Vertic – Inceptisol are well drained medium black and the depth varied from 30 – 45 cm with excess lime nodules in the sub soils.

The soil of the experimental site was clay in texture with bulk density of 1.35 g/cc, pH of 8.11 with organic carbon content of 0.32%. The soils were low in available N (154 kg/ha) and available P₂O₅ (16 kg/ha) and medium in available K₂O (308 kg/ha). The experiment

was laid out in a randomized complete block design with three replications. Application of tank silt @ 1886, 1650 and 1179 t/ha, respectively in T₃, T₄ and T₅ treatments in the initial period and respective organics were applied to the set furrows as per the treatment before sowing of the first crop in every year along with the recommended dose of fertilizer (50:25:0 kg and 35:50:35 kg N:P₂O₅:K₂O/ha for pearl millet and sunflower, respectively) and FYM (7 t/ha) expect in farmer's practice (63 kg urea and 63 kg DAP/ha).

The enumeration of total bacteria, fungi, actinomycetes, azotobacter, phosphate solubilizing bacteria and *Fluorescent pseudomonas* in the fresh soil samples was carried out by following the standard serial dilution plate count technique using Nutrient agar, Martin's Rose Bengal agar, Kuster's agar, Norrin – Nitrogen free glucose medium Pikovaskaya's medium and Kings B agar medium respectively.

Results and Discussion

Pearlmillet yield

Vertic-Inceptisols are characterized by low to very low available water holding capacity because of their lower depth. Consequently they support the crop growth for not more than 90 days.

Application of tank silt to a desired depth on the soil surface on entire land known to increase the available water holding capacity of such soils but it is very costly process. Hence, its application in set furrows is cheaper and affordable technique.

The technique of its application in set furrows was widely used in vertic-inceptisol of Northern Dry zone of Karnataka. In the present investigation, application of tank silt + crop residue in set furrows with paired row

spacing (45-135-45 cm) recorded significantly higher pearl millet grain yield (1737 kg/ha) over rest of the treatments. However, it was on par with the treatment receiving tank silt + crop residue in set furrows either with wider row (135 cm) or paired row planting techniques (45-90-45 cm) (Table 1).

The extent of yield increase with tank silt + crop residue application in set furrows was 77.24, 22.58, 21.38 and 20.37 per cent over farmers practice (980 kg/ha), flatbed with wider row planting (1417 kg/ha) and paired row spacing of 45-90-45cm (1431 kg/ha) and 45-135-45cm (1443 kg/ha), respectively. Addition of tank silt or sediment to cultivated fields increases the crop growth and yield (Ramesh, 2001 and Binita, 2006). It is evident from the data that addition of tank silt + crop residue in set furrows with either paired row or wider row planting had conspicuous beneficial effect in achieving higher productivity. This increase in pearl millet yield could be attributed to the presence of tank silt and crop residues in set furrows, which reduce the runoff and soil loss.

These crop residues in set furrows act as barrier and conserve the rain water, increase the infiltration rate, moisture retention capacity and nutrient availability in the soil. Improvement in soil moisture conservation by adopting of set row cultivation with soil amendments had also been reported by Mishra, (2002) and Anonymous, (2005).

Microbial population

The beneficial effect of crop residues on the soil organic carbon content and nutrient availability in turn influenced the nutrient uptake and crop yields. Degradation of crop residues in set furrows by soil microflora is often accelerated in the presence of soil fauna (Seastedt, 1984 and Tain *et al.*, 1995). Soil

microflora need regular maintenance of soil organic matter at higher level. In the present study, considerable improvement in the population of soil microflora was noticed. The bacteria, fungi, actinomycetes, azotobacter, PSB and *Fluorescent pseudomonas* population (pooled) were significantly higher with the application of tank silt + crop residue in set furrow with paired row spacing of 45-90-45 cm (26.13 CFU/g of soil $\times 10^7$, 16.16, 14.78, 19.77, 29.65, 25.14 CFU/g of soil $\times 10^4$, respectively) as compared to other treatments.

However, the superior treatment was on par with application of tank silt + crop residue in set furrows with wider and paired row spacing of 135 cm and 45-135-45 cm. The increase in population was 70.34, 130.2, 113.8, 139.0 and 143.4 per cent, respectively over farmers' practice (15.34, 7.02, 6.14, 8.27, 12.18 and 10.84 cfu/g of soil) (Table 2 and 3). The soil organic carbon (0.39 %) level with addition of tank silt + crop residue and respective crop residue incorporation in set furrows played vital role for enhanced microbial activity.

Anonymous (1998) opined that residue incorporation in set row cultivation were found to be support more number of bacteria, fungi, actinomycetes, azotobacter and P solubilizers population. Incorporation of crop residues stimulated microorganism's population (Manna and Ganguly, 2001).

Performance of succeeding sunflower yield

Use of tank sediment, which is said to be available in plenty, is presumed to be a novel practice. However, making use of tank sediments, as an additive for the soil is said to supplement essential plant nutrients including micronutrients and improve soil physical, chemical and biological properties for sustained crop production (Keshavamurthy and Kotur, 1996).

Table.1 Yield of pearl millet and sunflower as influenced by the tank silt + crop residue application and Row spacing under set row cultivation (Pooled over 3 years)

Treatment	Pearlmillet yield (kg/ha)				Sunflower yield (kg/ha)			
	2004	2005	2006	Pooled	2004-05	2005-06	2006-07	Pooled
Farmers' practice (35 cm)	997	947	997	980	260	158	517	312
Recommended practice (60 cm)	1153	1180	1253	1196	387	255	650	430
Tank silt + CR in set furrows (135 cm)	1493	1753	1853	1700	657	480	1013	717
Tank silt + CR in set furrows (45–90–45 cm)	1500	1773	1873	1716	603	447	973	674
Tank silt + CR in set furrows(45–135–45cm)	1560	1745	1907	1737	620	464	997	694
Flatbed (135 cm)	1227	1459	1567	1417	502	345	817	555
Flatbed (45 – 90 – 45 cm)	1350	1457	1487	1431	463	297	793	518
Flatbed (45 – 135 – 45 cm)	1280	1447	1603	1443	482	310	800	531
S. Em ±	93	70	74	43	29	26	30	21
C.D at 5%	281	213	225	129	88	79	90	62

CR – Crop residue

Table.2 Soil microbial population at grand growth period of pearl millet as influenced by the tank silt + crop residue application and Row spacing under set row cultivation (Pooled over 3 years)

Treatment	Bacteria (CFU /g soil X 10 ⁷)				Fungi (CFU /g soil X 10 ⁴)				Actinomycetes (CFU /g soil X 10 ⁴)			
	2004	2005	2006	Pooled	2004	2005	2006	Pooled	2004	2005	2006	Pooled
Farmers' practice (35 cm)	14.74	15.11	16.17	15.34	6.33	7.05	7.67	7.02	5.25	6.10	7.08	6.14
Recommended practice (60 cm)	15.29	17.11	18.78	17.06	7.56	8.00	8.58	8.04	6.67	7.67	8.48	7.61
Tank silt + CR in set furrows (135 cm)	20.22	24.30	29.53	24.68	11.87	14.66	17.42	14.65	10.73	13.86	14.81	13.13
Tank silt + CR in set furrows (45–90–45 cm)	22.06	26.03	30.31	26.13	12.67	16.43	19.37	16.16	12.67	15.14	16.54	14.78
Tank silt + CR in set furrows (45–135–45 cm)	20.78	25.11	29.69	25.19	13.11	15.11	18.56	15.59	11.66	14.33	14.96	13.65
Flatbed (135 cm)	15.67	18.91	20.53	18.37	9.84	10.51	11.89	10.75	7.81	9.38	10.68	9.29
Flatbed (45 – 90 – 45 cm)	17.28	20.40	21.65	19.78	10.25	11.67	11.20	11.07	8.67	10.67	11.41	10.25
Flatbed (45 – 135 – 45 cm)	16.34	19.67	20.43	18.81	10.00	10.12	10.67	10.26	9.33	11.11	11.37	10.60
S. Em ±	0.91	0.84	1.24	0.72	0.50	0.80	0.90	0.44	0.63	0.65	0.80	0.47
C.D at 5%	2.76	2.55	3.77	2.18	1.53	2.42	2.73	1.35	1.92	1.98	2.43	1.42

CR – Crop residue

Table.2a Soil microbial population at grand growth period of pearl millet as influenced by the tank silt + crop residue application and Row spacing under set row cultivation (Pooled over 3 years)

Treatment	Bacteria (CFU/g of soil X 10 ⁷)	Fungi (CFU/g of soil X 10 ⁴)	Actinomyces (CFU/g soil X 10 ⁴)	Azotobacter (CFU/g soil X 10 ⁴)	PSB (CFU/g soil X 10 ⁴)	FPs (CFU/g soil X 10 ⁴)
Farmers' practice (35 cm)	15.34	7.02	6.14	8.27	12.18	10.84
Recommended practice (60 cm)	17.06	8.04	7.61	10.08	16.14	13.56
Tank silt + CR in set furrows (135 cm)	24.68	14.65	13.13	18.07	27.41	23.72
Tank silt + CR in set furrows (45–90–45 cm)	26.13	16.16	14.78	19.77	29.65	25.14
Tank silt + CR in set furrows (45–135–45 cm)	25.19	15.59	13.65	18.87	28.55	24.39
Flatbed (135 cm)	18.37	10.75	9.29	12.97	20.73	16.20
Flatbed (45 – 90 – 45 cm)	19.78	11.07	10.25	14.46	22.32	17.93
Flatbed (45 – 135 – 45 cm)	18.81	10.26	10.60	14.30	21.65	16.92
S. Em ±	0.72	0.44	0.47	0.50	0.92	0.80
C.D at 5%	2.18	1.35	1.42	1.51	2.79	2.44

CR – Crop residue PSB – Phosphate Solubilizing Bacteria CFU – Colony Farming units FPs – Fluorescent Pseudomonas

Table.3 Soil microbial population at grand growth period of pearl millet as influenced by the tank silt + crop residue application and Row spacing under set row cultivation (Pooled over 3 years)

Treatment	Azotobacter (CFU /g soil X 10 ⁴)				PSB (CFU /g soil X 10 ⁴)				FPs (CFU /g soil X 10 ⁴)			
	2004	2005	2006	Pooled	2004	2005	2006	Pooled	2004	2005	2006	Pooled
Farmers' practice (35 cm)	7.48	8.50	8.82	8.27	10.44	12.33	13.78	12.18	9.66	10.33	12.51	10.84
Recommended practice (60 cm)	9.65	9.83	10.75	10.08	13.73	15.66	19.03	16.14	12.32	13.30	15.06	13.56
Tank silt + CR in set furrows (135 cm)	16.63	17.89	19.69	18.07	23.86	28.33	30.05	27.41	20.79	23.89	26.48	23.72
Tank silt + CR in set furrows (45–90–45 cm)	18.00	19.67	21.63	19.77	25.67	30.60	32.67	29.65	22.04	25.00	28.39	25.14
Tank silt + CR in set furrows (45–135–45 cm)	17.66	18.33	20.61	18.87	24.70	29.11	31.84	28.55	21.61	24.21	27.34	24.39
Flatbed (135 cm)	11.86	11.34	15.70	12.97	16.74	20.76	24.68	20.73	13.68	15.70	19.22	16.20
Flatbed (45 – 90 – 45 cm)	12.67	13.67	17.03	14.46	18.00	22.17	26.80	22.32	15.37	17.33	21.08	17.93
Flatbed (45 – 135 – 45 cm)	13.11	13.08	16.71	14.30	17.88	21.10	25.97	21.65	14.63	16.44	19.67	16.92
S. Em ±	1.04	0.65	0.85	0.50	0.93	0.99	1.04	0.92	0.91	0.70	1.21	0.80
C.D at 5%	3.15	1.98	2.59	1.51	2.81	3.00	3.15	2.79	2.76	2.13	3.68	2.44

CR – Crop residue PSB – Phosphate Solubilizing Bacteria CFU – Colony Farming units FPs – Fluorescent Pseudomonas

Table.3a Soil microbial population at grand growth period of *rabi* sunflower as influenced by tank silt + crop residue application and Row spacing under set row cultivation (Pooled over 3 years)

Treatment	Bacteria (CFU/g of soil X 10 ⁷)	Fungi (CFU/g of soil X 10 ⁴)	Actionmyces (CFU/g soil X 10 ⁴)	Azotobacter (CFU/g soil X 10 ⁴)	PSB (CFU/g soil X 10 ⁴)	FPs (CFU/g soil X 10 ⁴)
Farmers' practice (35 cm)	12.13	8.27	6.65	8.27	12.18	10.84
Recommended practice (60 cm)	13.73	10.26	8.30	10.08	16.14	13.56
Tank silt + CR in set furrows (135 cm)	23.69	17.23	12.70	18.07	27.41	23.72
Tank silt + CR in set furrows (45–90–45 cm)	24.77	18.35	13.74	19.77	29.65	25.14
Tank silt + CR in set furrows (45–135–45 cm)	24.41	18.19	13.28	18.87	28.55	24.39
Flatbed (135 cm)	16.59	11.94	9.32	12.97	20.73	16.20
Flatbed (45 – 90 – 45 cm)	17.87	12.91	10.05	14.46	22.32	17.93
Flatbed (45 – 135 – 45 cm)	17.29	12.30	9.68	14.30	21.65	16.92
S. Em ±	0.64	0.43	0.30	0.57	0.92	0.80
C.D at 5%	1.84	1.22	0.92	1.64	2.79	2.44

CR – Crop residue SB – Phosphate Solubalizing Bacteria CFU – Colony Farming units FPs – Fluorescent Pseudomonas

Table.4 Soil microbial population at grand growth period of *rabi* sunflower as influenced by tank silt + crop residue application and row spacing under set row cultivation (Pooled over 3 years)

Treatment	Bacteria (CFU/g of soil X 10 ⁷)				Fungi (CFU/g of soil X 10 ⁴)				Actionmycetes (CFU/g soil X 10 ⁴)			
	2004-05	2005-06	2006-07	Pooled	2004-05	2005-06	2006-07	Pooled	2004-05	2005-06	2006-07	Pooled
Farmers' practice (35 cm)	12.56	9.44	14.38	12.13	8.33	7.18	9.30	8.27	6.43	5.58	7.93	6.65
Recommended Practice (60 cm)	14.22	11.66	15.31	13.73	10.06	9.39	11.33	10.26	8.36	6.77	9.76	8.30
Tank silt + CR in set furrows (135 cm)	23.85	19.33	27.90	23.69	16.91	15.88	18.89	17.23	12.92	10.70	14.49	12.70
Tank silt + CR in set furrows (45–90–45 cm)	25.47	19.67	29.16	24.77	18.28	16.44	20.32	18.35	14.06	11.15	16.01	13.74
Tank silt + CR in set furrows (45–135–45 cm)	24.76	20.03	28.43	24.41	17.66	17.85	19.06	18.19	13.33	11.01	15.50	13.28
Flatbed (135 cm)	16.93	13.98	18.87	16.59	11.67	10.24	13.90	11.94	9.46	7.83	10.67	9.32
Flatbed (45 – 90 – 45 cm)	18.30	15.22	20.10	17.87	12.37	11.33	15.03	12.91	10.16	8.70	11.28	10.05
Flatbed (45 – 135 – 45 cm)	17.36	14.78	19.73	17.29	12.29	10.43	14.17	12.30	9.68	8.56	10.82	9.68
S. Em ±	0.86	0.94	0.93	0.64	0.80	0.71	0.71	0.43	0.51	0.59	0.58	0.30
C.D at 5%	2.61	2.84	2.83	1.84	2.43	2.15	2.14	1.22	1.54	1.79	1.75	0.92

CR – Crop residue CFU – Colony Farming Units

Table.5 Soil microbial population at grand growth period of *rabi* sunflower as influenced by tank silt + crop residue application and Row spacing under set row cultivation (Pooled over 3 years)

Treatment	Azotobacter (CFU/g soil X 10 ⁴)				PSB (CFU/g soil X 10 ⁴)				FPs (CFU/g soil X 10 ⁴)			
	2004-05	2005-06	2006-07	Pooled	2004-05	2005-06	2006-07	Pooled	2004-05	2005-06	2006-07	Pooled
Farmers' practice (35 cm)	8.50	7.48	8.82	8.27	12.33	10.44	13.78	12.18	10.33	9.66	12.51	10.84
Recommended practice (60 cm)	9.83	9.65	10.75	10.08	15.66	13.73	19.03	16.14	13.30	12.32	15.06	13.56
Tank silt + CR in set furrows (135 cm)	17.89	16.63	19.69	18.07	28.33	23.86	30.05	27.41	23.89	20.79	26.48	23.72
Tank silt + CR in set furrows (45–90–45 cm)	19.67	18.00	21.63	19.77	30.60	25.67	32.67	29.65	25.00	22.04	28.39	25.14
Tank silt + CR in set furrows (45–135–45 cm)	18.33	17.66	20.61	18.87	29.11	24.70	31.84	28.55	24.21	21.61	27.34	24.39
Flatbed (135 cm)	11.34	11.86	15.70	12.97	20.76	16.74	24.68	20.73	15.70	13.68	19.22	16.20
Flatbed (45 – 90 – 45 cm)	13.67	12.67	17.03	14.46	22.17	18.00	26.80	22.32	17.33	15.37	21.08	17.93
Flatbed (45 – 135 – 45 cm)	13.08	13.11	16.71	14.30	21.10	17.88	25.97	21.65	16.44	14.63	19.67	16.92
S. Em ±	0.65	1.04	1.21	0.57	0.99	0.93	1.37	0.92	0.70	0.91	1.21	0.80
C.D at 5%	1.98	3.15	3.67	1.64	3.00	2.81	4.15	2.79	2.13	2.76	3.68	2.44

CR – Crop residue

PSB – Phosphate Solubilizing Bacteria

CFU – Colony Farming units

FPs – Fluorescent Pseudomonas

The pooled analysis indicated that, application of tank silt + crop residue in set furrows with wider row spacing (135 cm) recorded the highest sunflower yield (717 kg/ha) followed by tank silt + crop residue in set furrows with paired row planting of 45-90-45 cm and 45-135-45 cm (674 and 694 kg/ha, respectively) and were significantly higher over farmers practice (312 kg/ha) (Table 1). Binita (2006) and Annadurai *et al.*, (2005) revealed that tank silt as amendment enhanced the production of different crops. The increase in sunflower yield with tank silt + crop residue in set furrow having wider spacing (135 cm), paired row spacing of 45-90-45 cm and 45-135-45 cm over farmers practice was 130, 116 and 122 per cent, respectively. The increased yield may be due to higher soil moisture and nutrient availability in the soil. Tank silt increased the soil moisture content and nutrient availability in the soil. The results are in conformity with the findings of Anonymous (2005). According to them application of tank silt in set furrows increased the sunflower yield by 55 per cent over farmers practice. Again they reiterated that maximum grain yield of sunflower was obtained under set row cultivation with wider row spacing (135 cm) as compared to farmers practice.

Microbial population

In the present study, considerable improvement in the population of soil micro-organisms was noticed. Application of tank silt + crop residue in set furrows with paired row spacing of 45-90-45 cm registered significantly higher population of bacteria (24.77 CFU/g of soil $\times 10^7$), fungi (18.35 CFU/g of soil $\times 10^4$), actinomycetes (13.74 CFU/g of soil $\times 10^4$), azotobacter (19.77 CFU/g of soil $\times 10^4$), PSB (29.65 CFU/g of soil $\times 10^4$) and FPs (25.14 CFU/g of soil $\times 10^4$) as compared to the other treatments. However, it was on par with tank silt + crop

residue application in set furrows with wider and paired row spacing of 135 cm and 45-135-45 cm. The increase in population was 104, 122, 107, 139, 147 and 132 per cent, respectively over farmers' practice (Table 4 and 5). Improvement in the soil organic carbon content by addition of tank silt and respective crop residues in set furrows with wider planting pattern might have played vital role in enhancing microbial activity. Angers *et al.*, (1995) were of the opinion that, dynamics of soil organic matter and microbial biomass were most important and had greater influence on soil fertility enrichment. Incorporation of crop residues might stimulated the populations of nitrogen fixing bacteria *viz.*, *Azotobacter* and *Rhizopus* sp., bacteria and actinomycetes bacteria, actinomycetes, fungi and ammonifying bacterial population in the soil (Mukharjee *et al.*, 1990). Hence it may conclude that, Application of tank silt + crop residue in set furrows with either wider or paired row planting was found to be optimum to improve pearl millet (1700 and 1737 kg/ha, respectively) and sunflower yield (717 and 694 kg/ha, respectively) and it also helps in improve the crop and soil productivity of Vertic-Inceptisol.

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