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Effect of moisture conservation practices on yield and economics of pigeonpea (*Cajanus cajan* L.) in black soil

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Abstract
A two-year field experiment was conducted at Main Agricultural Research Station, Raichur in 2021 and 2022 was laid out in a Split-Split design with four main, two sub and two sub-sub treatments with three replications to evaluate effect of conservation agricultural practices on growth and yield of pigeonpea. The treatments with flat bed, Compartment bund, Ridge and furrow & Broad bed and furrow were takes on main, treatments with mulching and without mulching an sub treatment and FYM and RDF & FYM an sub-sub treatment. Among them ridges and furrow (M_3) method along with mulching FYM and RDF was found to have positive influence of yield and economics of pigeonpea. Adopting the ridge and furrow method can be an effective strategy for optimizing the grain yield (1555 kg ha^{-1} and 1599 kg ha^{-1}) and cost of cultivation, gross returns, net returns and BC ratio (46991.36 Rs ha^{-1}, 116024.7 Rs ha^{-1}, 72189.2 Rs ha^{-1} and 2.78) in 2021 and 2022 in pigeonpea crop respectively.

Keywords: Pigeonpea, growth and yield attributes, grain yield

Introduction
Conservation agriculture means a set of soil management practices that minimize the soil disruption of the soil structure, compaction and natural biodiversity. These practices found to improve the fertility status, variation in total nitrogen content, different fraction of labile carbon pools along with different physical and biological activities of soil which generally contributes the overall quality of the soil. The advantage of CA in terms of better soil quality considers through lower bulk density (BD), increased water holding capacity, higher aggregate stability and better soil structure. On the other hand, CA practices influences soil biological parameters which affect the overall soil quality as it improves the quality, quantity and distribution of organic matter in soil which is a vital factor that largely affect biomass, diversity and activity of soil microorganism as it is the main source of food for soil biota (Reicosky and Saxton, 2007) [4].

Conservation agriculture has proven potential to improving the long-term environmental and financial sustainability of farming. The technology of conservation agriculture provides opportunities to reduce the cost of production save water and nutrients, increase yield. It maintains a soil cover through surface retention of crop residue with no tillage or zero tillage and reduced tillage. Potential benefits of CA include reduction in cost of production, reduced incidence of weeds, saving water and nutrients, increased yields, resource improvement and environmental benefits. Further, it improves physical, chemical and biological qualities of the soil. In pigeonpea, studies on evaluating effect of soil conservation practices are limited and scanty. Hence, assessing effect of soil conservation measures on soil physical, chemical and biological properties, nutrient content and its uptake and yield in sole crop stand of pigeonpea on which present study is aimed occupies its importance.

Considering these above views, the present investigation with the title “Effect of moisture conservation practices on yield and economics of pigeonpea (*Cajanus cajan* L.) in black soil” was undertaken with the following objective to study the effect of conservation agriculture practices on growth attributes and yield of pigeonpea.

Material and Methods
The field experiment was conducted at Main Agricultural Research Station, Raichur, The experiment was laid out in a Split-Split design with four main, two sub and two sub-sub treatments with three replications for study *viz.*

Treatment Details	Black soil
Main plot: Moisture conservation practices (Interbund management)	
M_1 - Flat bed	-
M_2 - Compartment bund	5.4 m × 7.5 m
M_3 - Ridges and furrow	60 cm furrow
M_4 - Broad bed and furrow	120 cm bed
Subplot:	
S_1 - Crop residue mulching	18-20 t ha^{-1}
S_2 - Without mulching	-
Sub- sub-plot:	
N_1 - RDF N: P_2O_5:K_2O	25:50:0 kg ha^{-1}
N_2 - RDF with FYM	RDF + FYM 6.0 t ha^{-1}

The soils of the experimental site belong to medium deep black soil and clay texture, neutral in soil reaction (7.6) and low in electrical conductivity (0.22 dSm^{-1}). The soil organic carbon content was 4.6 g kg^{-1} and available N (263.42 kg ha^{-1}), available phosphorus (28.68 kg P_2O_5 ha^{-1}) and available potassium (451 kg K_2O ha^{-1}), exchangeable calcium and magnesium (24.82 and 7.86 C mol (p^+) kg), available sulphur (13.30 mg kg^{-1}). The monthly meteorological data for the period of experimentation 2021-2022and 2022-2023were collected at Meteorological Observatory, Main Agricultural Research Station, Raichur**.** Annual mean rainfall received was 613 mm and 474 mm during 2021-22 and 2022-23 respectively. However, the distribution of rainfall was erratic.

Results and Discussion

Seed yield (kg ha^{-1})

During the years 2021 and 2022, the analysis of seed yield (kg ha^{-1}) revealed that the ridges and furrow (M_3) method consistently had significantly higher values compared to the broad bed and furrow (M_4) and flat-bed (M_1) methods (Table 1). The seed yield values were 1555 kg ha^{-1}, 1424 kg $ha^{-1}$and 1212 kg ha^{-1} for the ridges and furrow (M_3) method in 2021, and 1599 kg ha^{-1}, 1460 kg ha^{-1} and 1238 kg ha^{-1} in 2022, respectively. When considering the pooled data from both years, the ridges and furrow (M_3) method consistently recorded higher seed yield values of 1577 kg ha^{-1}, 1442 kg ha^{-1} and 1225 kg ha^{-1}compared to the broad bed and furrow (M_4) and flat-bed (M_1) methods, respectively. Based on these findings, the ridges and furrow (M_3) method is recommended for achieving better seed yield (kg ha^{-1}). The findings suggest that the ridge and furrow method can be a valuable technique for improving the seed yield of pigeonpea. By creating raised ridges and sunken furrows, the method optimizes water distribution and reduces waterlogging, leading to improved plant growth and higher seed yield (Palaniappan *et al.*, 2009 and Pandey *et al.*, 2015) [2, 3].

Similarly, in the years 2021 and 2022, the analysis showed that the crop residue mulching (S_1) method had significantly higher seed yield values compared to the without mulching (S_2) method (Table 1). The seed yield values were 1509 kg $ha^{-1}$and 1321 kg ha^{-1} in 2021, and 1548 kg ha^{-1} and 1353 kg ha^{-1} in 2022 for the crop residue mulching (S_1) and without mulching (S_2) methods, respectively. The pooled data from both years also consistently showed higher seed yield values of 1528 kg ha^{-1} for the crop residue mulching (S_1) method compared to 1337 kg ha^{-1} for the without mulching (S_2) method (Table 1). Therefore, the crop residue mulching (S_1) method is recommended for achieving better seed yield (kg ha^{-1}). This demonstrated that the crop residue mulching method positively impacted the seed yield of pigeonpea. Incorporating crop residues as mulch in pigeonpea cultivation can be a sustainable and effective approach to enhance seed yield (Kumawat *et al.*, 2013) [5].

The analysis of seed yield (kg/ha) in 2021 and 2022 did not show any significant difference between the FYM with RDF (N_2) and RDF N: P_2O_5:K_2O (N_1) fertilizers (Table 1). However, the FYM with RDF (N_2) consistently had higher seed yield values compared to the RDF N:P_2O_5:K_2O (N_1) fertilizer. In 2021, the values were 1440 kg ha^{-1} for FYM with RDF (N_2) and 1391 kg ha^{-1} for RDF N:P_2O_5:K_2O (N_1), while in 2022, the values were 1475 kg ha^{-1} and 1425 kg ha^{-1}, respectively (Table 11). When the data from both years was pooled, the FYM with RDF (N_2) still exhibited higher values of 1457 kg ha^{-1} compared to 1408 kg ha^{-1} for the RDF N:P_2O_5:K_2O (N_1) fertilizer (Table 1). The non-significant results might indicate that the particular combination of FYM with RDF (N_2) and RDF N:P_2O_5:K_2O (N_1) did not result in noticeable differences in seed yield compared to the control or other treatments.

In the pooled data for 2021 and 2022, the different three-way combinations for seed yield (kg ha^{-1}) did not show any significant difference (Table 5) (Figure 1). The combination of ridges and furrow (M_3), crop residue mulching (S_1) and FYM with RDF (N_2) had the highest seed yield value of 1721 kg ha^{-1}, followed by ridges and furrow (M_3), crop residue mulching (S_1) and RDF N:P_2O_5:K_2O (N_1) with a value of 1646 kg ha^{-1} and compartment bund (M_2), crop residue mulching (S_1) and FYM with RDF (N_2) with a value of 1617 kg ha^{-1} (Table 1). Similar trends were observed for individual years. It is important to note that the lack of significance does not necessarily imply that these combinations are ineffective or unimportant. Other factors such as environmental conditions, genetic variability and management practices may also contribute to seed yield variation.

To study the effect of different soil moisture conservation practices on economics of pigeonpea

Economic analysis is one of the major criteria for evaluating efficiency and economical effect of conservation agriculture practices in pigeonpea. The data on cost of cultivation, gross returns, net returns and benefit cost ratio of conservation agriculture practices in pigeonpea production for per hectare as influenced by various treatments is depicted in Table 2 to 5.

Cost of Cultivation (₹ ha^{-1})

The cost of cultivation for different conservation agriculture practices as influenced by various treatments is depicted in Table 2.

Based on pooled data, it was found that M_1 recorded least cost of cultivation among M_1, M_2, M_3 and M_4. Highest cost of cultivation is associated with ridges and furrow method (M_3)

followed by compartment bund (M_2), broad bed and furrow (M_4) while flatbed method was found to have least cost of cultivation and hence can be considered as cheapest method with the cost of Rs.39578.77, 43833.42, 43190.67, 42869.36 and 39578.77, respectively.

Among the crop residue mulching (S_1) method and without mulching (S_2) methods, S_1 was found to be costlier than S_2 method. Cost involved in using S_1 and S_2 was Rs. 45048.36 and 39687.75 indicating that using without mulching can reduce the cost of the cultivation.

Significantly higher cost of cultivation was recorded with the application of RDF $N:P_2O_5:K_2O$ (N_1) compared to FYM with RDF (N_2). N_1 has the highest cost of Rs. 45543.78 while it was 39192.33 for N_2 indicating its cost efficiency over other method to adopt among conservation agriculture practices.

Among the combinations of treatments or conservation agriculture practices, flat-bed method (M_1), without mulching (S_2) method and RDF $N:P_2O_5:K_2O$ (N_1) recorded lowest cost of cultivation (36301.11) while ridges and furrow (M_3) method, crop residue mulching (S_1) method and FYM with RDF (N_2) was found to be costliest approach among them. Though this combination among conservation agriculture practices involves high cost of cultivation, it can incur profit as it contributed high yield of pigeon compared to other methods.

Gross Returns (₹ ha $^{-1}$)

The data pertaining to the gross returns for different conservation agriculture practices as influenced by various treatments is depicted in Table 3.

During 2021-22, highest gross return (Rs. 112871.13) was observed for ridges and furrow (M_3) method and least (Rs. 88459.23) was noticed in flat-bed (M_1) among M_1, M_2, M_3 and M_4. During 2022-23, pattern remained same with the values Rs. 116018.33 and Rs. 90388.53, respectively. Based on the pooled data, it can be concluded that ridges and furrow method is feasible approach with high gross return (Rs. 114444.73) while the flatbed method involves lowest gross returns (Rs. 89398.88).

Among N_1 and N_2, FYM with RDF (N_2) (Rs. 104621.26) was found to have highest gross return against RDF $N:P_2O_5:K_2O$ (N_1) (Rs. 101145.15) when estimated during 2021 while the pattern remained same for the year 2022 with the values of Rs. 107221.61 and Rs. 103678.94, respectively. Pooled data revealed that N_2 (Rs. 105921.43) incurs high gross returns compared to N_1 (Rs. 102412.04).

Comparison of gross returns among crop residue mulching (S_1) method and without mulching (S_2) method indicated that crop residue mulching (S_1) method results in more gross returns with an amount of Rs. 109551.49 and Rs. 96214.92 during 2021 and 2022, respectively. Gross returns based on pooled data also indicated to draw similar conclusions with a highest gross return of Rs. 110972.69.

Among the combinations of treatments, it was found that ridges and furrow (M_3) method, crop residue mulching (S_1) method and FYM with RDF (N_2) results in highest gross returns of Rs. 124674.55 while flatbed method (M_1), without mulching method (S_2) and RDF $N:P_2O_5:K_2O$ (N_1) has the lowest gross returns. Similar pattern has been observed for the individual years. Hence, ridges and furrow (M_3) method, crop residue mulching (S_1) method and FYM with RDF (N_2) can be followed to attain high gross returns.

Net Returns (₹ ha $^{-1}$)

The data pertaining to the net returns for different conservation agriculture practices as influenced by various treatments is depicted in Table 4.

During 2021-22, highest net return (Rs. 69037.71) was observed for ridges and furrow (M_3) method and least (Rs. 48880.46) was noticed in flat-bed (M_1) among M_1, M_2, M_3 and M_4. During 2022-23, pattern remained same with the values Rs. 72184.91 and 50759.77, respectively. Based on the pooled data, it can be concluded that ridges and furrow method is feasible approach with high net returns (Rs. 70611.31) while the flatbed method involves lowest net returns (Rs. 49820.12).

Among N_1 and N_2, RDF $N:P_2O_5:K_2O$ (N_1) (Rs. 61952.82) was found to have highest gross return against FYM with RDF (N_2) (Rs. 59077.48) when estimated during 2021 while the pattern remained same for the year 2022 with the values of Rs. 64486.60 and Rs. 61677.84, respectively. Pooled data revealed that N_1 (Rs. 63219.71) incurs high gross returns compared to N_2 (Rs. 60377.66).

Comparison of net returns among crop residue mulching (S_1) method and without mulching (S_2) method indicated that crop residue mulching (S_1) method results in more net returns with an amount of Rs. 61952.82 and Rs. 64486.60 during 2021 and 2022, respectively. Pooled data also indicated that S_1 is better which results in highest net return (Rs. 63219.71).

Among the combinations of treatments, it was found that ridges and furrow (M_3) method, crop residue mulching (S_1) method and RDF $N:P_2O_5:K_2O$ (N_1)results in highest net returns of Rs. 76052.89 while flatbed method (M_1), without mulching (S_2) and FYM with RDF (N_2) has the lowest net returns (Rs. 49307.54). Similar pattern has been observed for the individual years. Hence, ridges and furrow (M_3) method, crop residue mulching (S_1) method along with RDF $N:P_2O_5:K_2O$ (N_1) can be followed to obtain high net returns.

BC Ratio

The data pertaining to the BC ratio for different conservation agriculture practices as influenced by various treatments is depicted in Table 5.

Among four methods *viz*., flat-bed (M_1), compartment bund (M_2), ridges and furrow (M_3) method and broad bed and furrow (M_4), during 2021, BC ratio was found to be highest for ridges and furrow (M_3) method followed by compartment bund (M_2), broad bed and furrow (M_4) and least for flat-bed (M_1) with the values 2.59, 2.48, 2.42 and 2.25, respectively. Trend remained same for the year 2022 with BC ratios of 2.66, 2.53, 2.48 and 2.30, respectively. Further, Pooled data also indicated that M3 is more efficient method obtain high BC ratio (2.62).

With respect to RDF $N:P_2O_5:K_2O$ (N_1) and FYM with RDF (N_2), N_1 was found to have highest BC ratio of 2.58 indicating its economic feasibility compared to FYM with RDF (N_2) with an BC ratio of 2.29. During 2022, N_1 and N_2 had values of 2.64 and 2.35, respectively. The BC ratio was also high for the N_1 (2.61) based on pooled data of the two years indicating that approach is consistent in yielding higher returns.

Comparison of BC ratio among crop residue mulching (S_1) method and without mulching (S_2) method indicated that both the methods had on par with each other for BC ratio during 2021 (2.44 and 2.43) and 2022 (2.50 and 2.49), respectively. However, crop residue mulching (S_1) method had numerical superiority over without mulching (S_2) method in both the years. Pooled data also indicated that S_1 has numerical superiority compared to S_2 with BC ratio 2.47 and 2.46, respectively.

Among the combinations of treatments, it was found that ridges and furrow (M_3) method, crop residue mulching (S_1) and RDF N:P_2O_5:K_2O (N_1) results in highest BC ratio of 2.76 while flatbed method (M_1), without mulching (S_2) method and FYM with RDF (N_2) has the lowest BC ratio (2.15). Similar pattern has been observed for the individual years. Hence, ridges and furrow (M_3) method, crop residue mulching (S_1) along with RDF N:P_2O_5:K_2O (N_1) can be followed to obtain high benefit cost ratio by the farmers.

Table 1: Effect of different soil moisture conservation practices on seed yield per hectare

Seed Yield (kg/ha)										
M × S × N		**2021**			**2022**			**Pooled**		
		S_1	**S_2**	**Mean (M×N)**	**S_1**	**S_2**	**Mean (M×N)**	**S_1**	**S_2**	**Mean (M×N)**
M_1	N_1	1247.35	1100.75	1174.05	1273.33	1124.10	1198.71	1260.34	1112.43	1186.38
	N_2	1269.05	1234.22	1251.63	1295.28	1261.00	1278.14	1282.16	1247.61	1264.89
M_2	N_1	1563.22	1353.15	1458.19	1600.04	1384.55	1492.30	1581.63	1368.85	1475.24
	N_2	1595.23	1367.34	1481.29	1639.56	1395.83	1517.69	1617.40	1381.58	1499.49
M_3	N_1	1625.65	1444.98	1535.32	1667.34	1484.29	1575.82	1646.50	1464.63	1555.57
	N_2	1694.70	1458.45	1576.58	1747.42	1498.70	1623.06	1721.06	1478.58	1599.82
M_4	N_1	1508.42	1285.96	1397.19	1553.00	1320.80	1436.90	1530.71	1303.38	1417.05
	N_2	1571.54	1330.19	1450.87	1611.12	1357.81	1484.46	1591.33	1344.00	1467.66
Mean S		1509.39	1321.88		1548.39	1353.38		1528.89	1337.63	
M × S				**Mean M**	**M × S**		**Mean M**	**M × S**		**Mean M**
M	M_1	1258.20	1167.49	1212.84	1284.31	1192.55	1238.43	1271.25	1180.02	1225.64
	M_2	1579.23	1360.24	1469.74	1619.80	1390.19	1505.00	1599.52	1375.22	1487.37
	M_3	1660.17	1451.71	1555.94	1707.38	1491.49	1599.44	1683.78	1471.60	1577.69
	M_4	1539.98	1308.08	1424.03	1582.06	1339.30	1460.68	1561.02	1323.69	1442.36
N × S				**Mean N**	**N × S**		**Mean N**	**N × S**		**Mean N**
N	N_1	1486.16	1296.21	1391.19	1523.43	1328.43	1425.93	1504.79	1312.32	1408.56
	N_2	1532.63	1347.55	1440.09	1573.35	1378.33	1475.84	1552.99	1362.94	1457.97
SOV		**S.Em ±**	**CD at 5 %**		**S.Em ±**	**CD at 5 %**		**S.Em ±**	**CD at 5 %**	
M		36.53	126.42		34.28	118.63		27.29	94.44	
S		23.25	75.81		12.63	41.20		12.50	40.78	
N		24.10	NS		22.78	NS		16.88	NS	
M×S		46.49	NS		25.26	NS		25.01	NS	
M×N		48.20	NS		45.55	NS		33.75	NS	
S×N		34.08	NS		32.21	NS		23.87	NS	
M×S×N		68.17	NS		64.42	NS		47.73	NS	

Table 2: Cost of cultivation for different soil moisture conservation practices in pigeon pea

Cost of cultivation (Rs ha^{-1})				
M × S × N		**Pooled**		
		S_1	**S_2**	**Mean (M×N)**
M_1	N_1	38822.75	33779.48	36301.11
	N_2	44982.95	40729.89	42856.42
M_2	N_1	42858.72	37347.95	40103.33
	N_2	49116.18	43439.81	46278.00
M_3	N_1	43326.85	38024.13	40675.49
	N_2	49856.33	44126.38	46991.36
M_4	N_1	42494.98	36883.81	39689.39
	N_2	48928.12	43170.53	46049.32
Mean S		45048.36	39687.75	
M × S				Mean M
M	M_1	41902.85	37254.69	39578.77
	M_2	45987.45	40393.88	43190.67
	M_3	46591.59	41075.25	43833.42
	M_4	45711.55	40027.17	42869.36
N × S				Mean N
N	N_1	41875.83	36508.84	39192.33
	N_2	48220.90	42866.65	45543.78
SOV		S.Em ±	CD at 5 %	
MP		-	-	
SP		-	-	
MP*SP		-	-	
SSP		-	-	
MP*SSP		-	-	
SP*SSP		-	-	
MP*SP*SSP		-	-	

Table 3: Gross return for different soil moisture conservation practices in pigeonpea

Gross returns (Rs ha^{-1})										
M × S × N		**2021**			**2022**			**Pooled**		
		S_1	**S_2**	**Mean (M×N)**	**S_1**	**S_2**	**Mean (M×N)**	**S_1**	**S_2**	**Mean (M×N)**
M_1	N_1	90884.13	80549.19	85716.66	92839.15	82262.76	87550.95	91861.64	81405.98	86633.81
	N_2	92485.75	89917.86	91201.80	94395.74	91856.49	93126.12	93440.74	90887.17	92163.96
M_2	N_1	113357.43	98447.15	105902.29	116039.44	100734.17	108386.80	114698.44	99590.66	107144.55
	N_2	115662.70	99471.25	107566.97	118883.31	101553.02	110218.17	117273.00	100512.14	108892.57
M_3	N_1	117870.21	104927.36	111398.79	120889.29	107771.92	114330.61	119379.75	106349.64	112864.70
	N_2	122767.55	105919.40	114343.48	126581.54	108830.58	117706.06	124674.55	107374.99	116024.77
M_4	N_1	109439.24	93686.48	101562.86	112682.71	96212.06	104447.39	111060.97	94949.27	103005.12
	N_2	113944.88	96800.67	105372.77	116839.91	98832.29	107836.10	115392.39	97816.48	106604.44
Mean S		109551.49	96214.92		112393.89	98506.66		110972.69	97360.79	
		M × S		**Mean M**	**M × S**		**Mean M**	**M × S**		**Mean M**
M	M_1	91684.94	85233.53	88459.23	93617.44	87059.63	90338.53	92651.19	86146.58	89398.88
	M_2	114510.06	98959.20	106734.63	117461.38	101143.59	109302.49	115985.72	100051.40	108018.56
	M_3	120318.88	105423.38	112871.13	123735.42	108301.25	116018.33	122027.15	106862.31	114444.73
	M_4	111692.06	95243.57	103467.82	114761.31	97522.18	106141.74	113226.68	96382.88	104804.78
		N × S		Mean N	N × S		Mean N	N × S		Mean N
N	N_1	107887.75	94402.54	101145.15	110612.65	96745.23	103678.94	109250.20	95573.89	102412.04
	N_2	111215.22	98027.30	104621.26	114175.13	100268.09	107221.61	112695.17	99147.70	105921.43
SOV		**S.Em ±**	**CD at 5 %**		**S.Em ±**	**CD at 5 %**		**S.Em ±**	**CD at 5 %**	
MP		2553.99	8837.96		2382.70	8245.23		1898.00	6567.93	
SP		1590.83	5187.98		876.04	2856.91		849.37	2769.94	
MP*SP		3181.66	NS		1752.07	NS		1698.73	NS	
SSP		1681.72	NS		1589.61	NS		1181.46	NS	
MP*SSP		3363.44	NS		3179.22	NS		2362.92	NS	
SP*SSP		2378.31	NS		2248.05	NS		1670.84	NS	
MP*SP*SSP		4756.62	NS		4496.09	NS		3341.68	NS	

Table 4: Net return for different soil moisture conservation practices in pigeonpea

Net returns (Rs ha^{-1})										
M × S × N		**2021**			**2022**			**Pooled**		
		S_1	**S_2**	**Mean (M×N)**	**S_1**	**S_2**	**Mean (M×N)**	**S_1**	**S_2**	**Mean (M×N)**
M_1	N_1	52061.38	46769.72	49415.55	54016.40	48483.29	51249.84	53038.89	47626.50	50332.70
	N_2	47502.79	49187.96	48345.38	49412.79	51126.60	50269.69	48457.79	50157.28	49307.54
M_2	N_1	70498.71	61099.20	65798.95	73180.72	63386.22	68283.47	71839.71	62242.71	67041.21
	N_2	66546.52	56031.44	61288.98	69767.13	58113.21	63940.17	68156.82	57072.32	62614.57
M_3	N_1	74543.36	66903.23	70723.30	77562.43	69747.80	73655.11	76052.89	68325.51	72189.21
	N_2	72911.22	61793.02	67352.11	76725.21	64704.20	70714.73	74818.21	63248.61	69033.43
M_4	N_1	66944.26	56802.67	61873.52	70187.73	59328.26	64758.01	68565.99	58065.46	63315.71
	N_2	65016.76	53630.15	59323.45	67911.79	55661.77	61786.78	66464.27	54645.96	60555.11
Mean S		64503.12	56527.17		67345.52	58818.92		65924.32	57673.04	
		M × S		**Mean M**	**M × S**		**Mean M**	**M × S**		**Mean M**
M	M_1	49782.09	47978.84	48880.46	51714.59	49804.94	50759.77	50748.34	48891.89	49820.12
	M_2	68522.61	58565.32	63543.97	71473.92	60749.71	66111.82	69998.27	59657.52	64827.89
	M_3	73727.29	64348.13	69037.71	77143.82	67226.00	72184.91	75435.55	65787.06	70611.31
	M_4	65980.51	55216.41	60598.46	69049.76	57495.01	63272.38	67515.13	56355.71	61935.42
		N × S		**Mean N**	**N × S**		**Mean N**	**N × S**		**Mean N**
N	N_1	66011.93	57893.70	61952.82	68736.82	60236.39	64486.60	67374.37	59065.05	63219.71
	N_2	62994.32	55160.64	59077.48	65954.23	57401.44	61677.84	64474.27	56281.04	60377.66
SOV		**S.Em ±**	**CD at 5 %**		**S.Em ±**	**CD at 5 %**		**S.Em ±**	**CD at 5 %**	
MP		2553.99	8837.96		2382.70	8245.23		1898.00	6567.93	
SP		1590.83	5187.98		876.04	2856.91		849.37	2769.94	
MP*SP		3181.66	NS		1752.07	NS		1698.73	NS	
SSP		1681.72	NS		1589.61	NS		1181.46	NS	
MP*SSP		3363.44	NS		3179.22	NS		2362.92	NS	
SP*SSP		2378.31	NS		2248.05	NS		1670.84	NS	
MP*SP*SSP		4756.62	NS		4496.09	NS		3341.68	NS	

Table 5: BC ratio for different soil moisture conservation practices in pigeonpea

BC Ratio										
M × S × N		**2021**			**2022**			**Pooled**		
		S_1	**S_2**	**Mean (M×N)**	**S_1**	**S_2**	**Mean (M×N)**	**S_1**	**S_2**	**Mean (M×N)**
M_1	N_1	2.34	2.38	2.36	2.39	2.44	2.41	2.37	2.41	2.39
	N_2	2.06	2.21	2.13	2.10	2.26	2.18	2.08	2.23	2.15
M_2	N_1	2.64	2.64	2.64	2.71	2.70	2.70	2.68	2.67	2.67
	N_2	2.35	2.29	2.32	2.42	2.34	2.38	2.39	2.31	2.35
M_3	N_1	2.72	2.76	2.74	2.79	2.83	2.81	2.76	2.80	2.78
	N_2	2.46	2.40	2.43	2.54	2.47	2.51	2.50	2.43	2.47
M_4	N_1	2.58	2.54	2.56	2.65	2.61	2.63	2.61	2.57	2.59
	N_2	2.33	2.24	2.29	2.39	2.29	2.34	2.36	2.27	2.31
Mean S		2.44	2.43		2.50	2.49		2.47	2.46	
M × S				**Mean M**	**M × S**		**Mean M**	**M × S**		**Mean M**
M	M_1	2.20	2.30	2.25	2.24	2.35	2.30	2.22	2.32	2.27
	M_2	2.50	2.46	2.48	2.56	2.52	2.54	2.53	2.49	2.51
	M_3	2.59	2.58	2.59	2.66	2.65	2.66	2.63	2.62	2.62
	M_4	2.45	2.39	2.42	2.52	2.45	2.48	2.49	2.42	2.45
N × S				**Mean N**	**N × S**		**Mean N**	**N × S**		**Mean N**
N	N_1	2.57	2.58	2.58	2.64	2.64	2.64	2.60	2.61	2.61
	N_2	2.30	2.29	2.29	2.36	2.34	2.35	2.33	2.31	2.32
SOV		**S.Em ±**	**CD at 5 %**		**S.Em ±**	**CD at 5 %**		**S.Em ±**	**CD at 5 %**	
MP		0.06	0.21		0.06	0.19		0.05	0.16	
SP		0.04	NS		0.02	NS		0.02	NS	
MP*SP		0.08	NS		0.04	NS		0.04	NS	
SSP		0.04	0.12		0.04	0.12		0.03	0.09	
MP*SSP		0.08	NS		0.08	NS		0.06	NS	
SP*SSP		0.06	NS		0.05	NS		0.04	NS	
MP*SP*SSP		0.12	NS		0.11	NS		0.08	NS	

Conclusion
The combination of the ridges and furrow method, crop residue mulching and the application of FYM with RDF emerged as the most effective approach, consistently demonstrating superior performance across multiple parameters. By implementing these recommended practices, farmers and agricultural practitioners can optimize pigeonpea crop productivity, improve soil health and ultimately achieve better results.

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