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Relative impact of *in-situ* moisture conservation practices on growth parameter, root development and yield attributes of sorghum varieties under rainfed condition

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Abstract
A field experiment was conducted during the rainy season (kharif) of at Soil Conservation and water Management Farm, C.S. Azad University of agriculture and technology Kanpur to find out the relative impact of *in- situ* moisture conservation practices and fertility levels on sorghum varieties under rainfed condition. Various *in-situ* moisture conservation practices brought about enhancement in almost all growth parameters of sorghum crop namely, plant height, plant girth, plant canopy, root development, yield (grain and stover), yield attributes, The highest improvement was recorded under the treatment i.e. farmer practice + ridging and furrowing + mulching and improvement was found in the order of farmer practice + ridging + furrowing + mulching > farmer practice + mulching > farmer practice + ridging and furrowing > farmer practice + dhaincha mulching. The highest mean grain yield (32.67 q ha^{-1}), stover yield (109.48 q ha-^{1}) was recorded under farmer practice + ridging and furrowing + mulching in- situ moisture conservation practices. Similarly maximum mean yield (30.39 q ha-^{1}), stover yield (102.02 q ha-^{1}), was observed in N_{80} P_{40} K $_{40}$ fertility level. And higher mean grain yield (28.66 q ha-$^{1)}$, stover yield (100.42 q ha$^{-1)}$ was calculated in variety, Varsha.

Keywords: growth parameters, root development and yield attributes

Introduction
Sorghum locally known as jowar, is an annual cereal plant that belongs to family gramineae and botanically it is called *sorghum bicolor* (Linn.) Moench. It is one of the five major food gains of the world. Millions of people in Africa and Asia depend on sorghum as the stable food. In addition, its fodder and stover are fed to million of animals providing milk and meat for human being. It is also used as industrial raw material in various industries in USA and other developed countries, the products include alcohol, fuel alcohol, starch jiggery and various bakery products like bun, bread, cakes, cookies and biscuits.

In India sorghum ranks third in the major food grain crops. It has potential to compete effectively with crop like maize under good environment and management conditions. The greatest merit with sorghum is that it has capacity to withstand drought. Its performance is better than maize on marginal lands under moisture stress or excessive moisture conditions. It is one of the most widely grown dryland food grains in India. It does well even in low rainfall areas. It makes comparatively quick growth and gives not only good grain yield but also large quantities of fodder. Sorghum grain is eaten by human beings in India either by breaking the grain and cooking it in the same way as rice or by grinding it into flour and preparing 'Chapaties', To some extent it is also eaten as parched and popped and popped grain. This grain is also fed to cattle, poultry and swine, Sorghum grains contain about 10.4 per cent protein, 1.9 per cent fat, 72.6 per cent carbohydrates and 1.6 per cent mineral matter, therefore, it can satisfactorily replace other grains in the feeling program me for dairy cattle, poultry and swine.

The problems of rainfed areas are manifold and complex in nature. However, the main problem to which the other problems are associated is that of the uncertainty of rainfall and its poor control and management in the field, which lead to low and unstable agriculture production. Short span of rainy season and poor moisture retentivity of soils due to topographical and textural problems further aggravate the problem. Excess loss of water through runoff lead to water stress at the critical stages of the crop growth, which affect the yields adversely. Minimizing the risk factor *in-situ* moisture conservation practices, fertilization and adoption of suitable crops and varieties and agronomic practices are, there for vital for the success of dry land agriculture.

The sorghum production in the dry tract of Uttar Pradesh which is suffering which the problem of soil erosion, hybrid and high yielding sorghum varieties (‘Varsha ‘and‘ C.S.V.-13‘) give better response as compared to local varieties. Keeping the point in view, the present study entitled “Relative impact of *in- situ* moisture conservation practices and growth parameter, root development and yield attributes of sorghum varieties under rainfed condition”.

Materials and Methods

A field experiment was conducted during kharif seasons of 2003-2004 at Soil Conservation and Water Management Farm of the Chandra Shekhar Azad University of Agriculture and Technology Kanpur. Kanpur district is situated, form a part of lower Ganga-Yamuna doab. It is the spread over 115 km from North to South and 105 km East and West. It lies between the parallels of 25^0 26’ and 26^0 58’ North latitude and 79^0 31’ and 80^0 34’East longitude and is situated at an elevation of 129.0 meter above the mean sea level. The district falls within sub-tropical zone and has a semi-arid climate. The annual rainfall of the district is about 800 mm which mainly received from the middle June to September with some scattered showers in winter months, particularly in December, January or sometimes even in February. The mean maximum and minimum temperature are 40.1^0 c and 8.1^0 c, respectively. The soil of experimental field is a typical eroded Gangetic alluvium. The experiment was laid out in a three replicated split plot design of layout with 5 treatments of in-situ moisture conservation practices (i) M_o = Farmer practices (one weeding and hoeing by Kharief at 20 DAS (ii) $M_1 = M_o$+ organic residue mulch @ 4 t ha-^{1} at 20 DAS (iii) $M_2 = M_o$ + ridging and furrowing at 20DAS in between the row (iv) M_3 = M_o + ridging and furrowing followed by organic residue mulch @ 4 t ha-^{1} 20DAS (v) $M_4 = M_o$ + Dhaincha mulch after 25 DAS assigned to the main- plots and 2 fertility levels N+P+K (Kg ha^{-1}) (i) F_1 = 40+20+20 (i) F_2 = 80+40+40 and 2 sorghum varieties (i) V_1 = Varsha (ii) V_2 = CSV-13 randomly placed in sub-plots of the main plot. After final layout on the field half dose of the nitrogen and full dose of phosphorus and potash were applied through ‘nai’ behind in deshi plough in furrow 2-3 cm below with seed at sowing time to all plots, remaining half dose of nitrogen was top- dressed at 30 days after sowing. The seeds of jowar “ Varsha “ and “CSV-13” variety @ 15 kg ha^{-1} were sown in furrow by deshi plough at an usual seed rate with the help of manual laborers keeping row to row distance of 45 cm. Seed was sown 20-07-13 and 22-07-14 in both year respectively behind the deshi plough and harvested in CSV-13 variety 05-11-03 and 08-11-03 both year and Varsha variety 22-11-04 and 25-11-04 both respectively.

Result and Discussion

Growth parameters

The data presented in (Table 1, 2, 3) shows the different *in-situ* moisture conservation practices were found to influence markedly the various growth and development parameters of sorghum *viz*. plant height, plant girth and canopy development. FP + ridging and furrowing + mulching excelled over all other *in- situ* moisture conservation practices by exhibiting an all-round better effect on different growth and development parameters except on plant height at 30 DAS. At this stage significantly highest plant height was recorded under FP + Dhaincha mulching during both the years. Dhaicha mulch is growing of its plants in between two rows of sorghum crop to increase plant density. Plant height increase with increase in plant population due to competition for light. FP + mulching and FP + ridging and furrowing were at par in the growth parameters i.e. plant height, plant girth and canopy development at all the stages of growth during both the years. FP + ridging and furrowing + mulching enhanced more availability of nutrients which ultimately resulted in increased plant height, plant girth and canopy development of plant. These results corroborate the findings of Mane and Shingte (1982) and Tripathi and Bhan (1995) [27]. The plant height, plant girth and canopy development increased significantly at all the growth stages with increase in fertility level, being lowest with N_{40} P_{20} K_{20} and highest with N_{80} P_{40} K_{40}. The higher plant height, plant girth and canopy development with increasing nutrient application might be due to increase in the availability of nutrients. These results are supported by the findings of Chaudhary *et al.* (1992) [4], Patidar and Mali (2001) [22] and Kushwah *et at*. (2003) [16]. The two varieties of sorghum tested in the present experiment the initial growth was better in case of variety ‘CSV-13 ‘ but latter on particularly after 60 days of sowing variety ‘Varsha’ superceded ‘CSV-13’and maintained its superiority till harvest in almost all growth parameters, namely plant height, plant girth and canopy development. Variety ‘CSV-13’ also matured earlier (about 105 days) than variety Varsha (120 days). Since ‘Varsha’ continued its growth and development characters for longer period than short duration variety ‘CSV-13’. Since growth and development characteristics of different varieties are government by genetic makeup, hence the two varieties under study exhibited differential growth and development parameters. Varietal differences in growth and developmental parameter of sorghum have also been reported by Tharke *et al.* (1989), Naik (1990) [19].

Root development

The data root development i.e. primary root per plant, dry weight of roots per plant and depth of roots as influenced by various in-situ MCPs, fertility levels and sorghum varieties are given (Table 4). Root development under different *in-situ* MCPs was better over farmer practices. Among the different MCPs FP +ridging and furrowing +mulching excelled all other *in-situ* MCPs in almost all parameters of root development, namely, primary roots per plant and dry weight of root per plant. However, the root depth was shallowest under farmer practice+ ridging and furrowing + mulching and highest under farmer practice. With the application of mulch the root depth was suppressed while primary roots per plant and dry weight of roots per plant increased followed by FP+ ridging and furrowing and FP+ dhaincha mulching. This might be due to availability of more moisture and more nutrients under FP+ ridging and furrowing + mulching than other *in-situ* MCPs. These results lie in the line of findings reported by Bhan *et al.* (1995) [27], Tripathi and Bhan (1995) [27] and Katiyar (2001) [11]. The table also shows that nutrient both the years. The higher root development occurred under fertility levels of N_{80} P_{40} K_{40} compared to fertility level of N_{40} P_{20} K_{20}. The superior root parameters with higher fertility levels might be ascribed to increase in availability of nutrients contents of fertility level. Which resulted in higher root development. Similar results have been reported by Chaudhary *et al*. (1974) [5], Kuchan *et al*. (1989) [12], Nitant and Prakash (1989) [20], Bhan *et al.* (1995) [27] and Rajkannan *et al*. (2002) [23]. Varieties ‘Varsha’ exhibited an all-round better root development as measured by root depth, primary roots per plant and dry weight of roots per plant while the poorest root development was observed of 'CSV-13 '. Better root development of variety 'Varsha' may be attributed, firstly, to its long duration and secondly to its generic makeup. Varietal differences in root development in sorghum have also earlier been reported by Bhan *et al*. (1973) [27] who while screening sorghum varieties for their drought endurance ability came to conclusion that root development may be taken as a fair index of drought resistance in sorghum. Similar varietal differences in root development have been reported by Chand and Bhan (2002) [7].

Yield attributes

It is obvious from the data presented in (Table 5) that in-situ MCPs, fertility levels and sorghum varieties influenced, in general, the yield attributing characteristics i.e. weight of panicle, length of panicle, girth of panicle, number of grains per panicle and 1000 grain weight significantly during both years, except 1000 grain weight. Test weight of 1000 grain of both varieties were at par during both the year. *In-situ* MCPs play vital role in crop production by influencing growth promoting parameters, Under FP + ridging and furrowing + mulching system availability of moisture, air and plant nutrients would be higher as compared to farmer practices of *in-situ* MCPs, resulting in higher values of yield attributes under former situation as compared to latter, FP + mulching *in- situ* gave higher yield attributes than FP + ridging and furrowing. Though FP + mulching did not increase the yield attributes significantly over FP + ridging and furrowing. FP + mulching and FP + ridging and furrowing increased yield attributes over FP + dhaicha mulching and FP + dhaicha mulching significantly increased yield attributes in comparison to farmer practices. These results are supported by the findings of Tripathi and Bhan (1995) [27], Hebbi *et al.* (2002) [8] and Kumar and Gautam (2004) [13]. The significantly increase in the yield attributing parameters occurred with increase in fertility level (N_{80} P_{40} K_{40}) than lower fertility level of (N_{40} P_{20} K_{20}). The increase in yield attributes with higher fertility level might be attributed to increase in availability of nutrients (NPK), resulting in higher values of yield attributing parameters in the present investigation. These results are inconformity with the findings of Narang *et al*. (1989) [21], Sridhar *et al.*, (1991), Tripathi and Bhan (1995) [27], Rathor and Gautam (2003) [16], and Kumar and Thakur (2004) [18]. Variety 'Varsha' established its superiority over variety 'CSV-13' in respect in yield attributes i.e. weight of panicle, girth of panicle, number of grains per panicle and 1000- grain weight during both year. Variety 'CSV13'gave highest length of panicle. Superiority of Varsha under dryland condition have also been reported by Anonymous (1987-88), Tenchew (1995) and Kumar *et al*. (2003) [17].

Yields

The data presented in (Table 6) reveal that biological, grain and stover yield significantly affected by *in-situ* MCPs fertility levels and varieties during both years. The *in-situ* MCPs *viz*. FP + ridging and furrowing + mulching significantly increased biological, grain and stover yields in comparison to other *in-situ* MCPs, FP + mulching gave higher biological, grain and stover yields compared to FP + ridging and furrowing but did not reach to the level of significance. Due FP +ridging and furrowing + mulching soil become more porous, resulting in higher aeration and more proliferation of plant roots which caused higher plant nutrients observation and higher moisture availability resulting in higher biological, grain and stover yields. Brahmbhatt and Patil (1983) [3], and Tripathi and Bhan (1995) [27] also reported that furrowing and mulching combined together showed an additive effect with significantly higher grain and fodder yields of sorghum. From the data (Table 6) it is obvious that the higher biological yield obtained with the application of N_{80} P_{40} K_{40} was computed about 21.47 and 20.88 per cent higher than the lower biological yield obtained with N_{40} P_{20} K_{20} during both years. The higher grain yield obtained with the application of N_{80} P_{40} K_{40} was computed about 20.54 and 22.54 per cent higher than the lower grain yield obtained with N_{40} P_{20} K_{20} during both years, respectively, Similarly biological and grain yield, the higher stover yield obtained with N_{80} P_{40} K_{40} was found about 20.83 and 20.78 per cent higher than the lower stover yield with N_{40} P_{20} K_{20} during first and second years, respectively. Significantly improvement of production of crop o application of N_{80} P_{40} K_{40} could be ascribed to profound influence of N, P and k on plant growth and yield attributing characters of the crop causing increase in nutrients accumulation and their translocation towards the yield formation. These results are in conformity with the findings of Jadhav (1990) [10], Shrivastava and Sinha (1992) [25], Kushwah *et al*. (2003) [16], Rathor and Gautam (2003) [16] and Kaushik and Shaktawat (2005) [14]. It is variety 'Varsha 'was significantly superior over 'CSV-13'I biological, grain and stover yields with a difference of 18.08 and 14.02 q ha^{-1} in biological, of 2.13 and 1.71 q ha-[1] in given and 16.42 and 12.31 q ha^{-1} in stover during both years, respectively. Yield is the product of number of plant per unit area and the yield per plant. In present study the plant population per unit area was same in all the two varieties, hence the higher yield of variety 'Varsha' over that of 'CSV-13'may be attributed to higher yield per plant of farmer over the variety 'CSV-13'. The various yield attributes, namely the number of grains per panicle and 1000 grain weight which together make grain yield per panicle were significantly higher in case of 'Varsha' over 'CSV-13'. Similarly as various epithets *viz*. Plant height, plant girth and dry matter per plant were higher in case of 'Varsha' hence it gave higher stover yield over 'CSV-13'. Better performance of 'Varsha' over 'CSV-13' I respect of biological, gain and stover yields might be also attributed to its longer duration with better root development which helped in synthesizing and accumulating food material for longer period whereas due to stress condition on account of receding moisture condition the variety 'CSV-13'suffered. Superiority of 'Varsha' under dryland condition have also been reported by Huda *et al*. (1987) [9], Wanjari *et al*. (1995) [30], Kushwah *et al.* (2001) [15] and Chaudhary *et al*. (2004) [6].

Harvest index

The data presented in (Table 6) visualize that the *in-situ* MCPs, fertility levels did not have conspicuous effect on harvest index but harvest index was influenced significantly by varieties, Since, the harvest index is obtained by dividing the grain yield with biological yield and multiplied by hundred, therefore, the harvest index values varied depending upon the grain and stover yield obtained under the influence of different treatments. The various *in-situ* MCPs i.e. FP + ridging and furrowing + mulching obtained highest harvest index and minimum under farmer practice during both years. The harvest index was also influenced due to fertility levels. The higher harvest index was noted with N_{80} P_{40} K_{40} and lower with N_{40} P_{20} K_{20} during both years. These results are substantiated by the findings of Kumar and Gautam (2004) [13]. The harvest index of variety 'Varsha' was found to be lower than 'CSV-13'during both years which may be attributed to higher stover yield of 'Varsha' which in greater propagation than the grain yield. Under dryland conditions since both grain and stover yield are important, hence the biological yield of 'Varsha' is of great significant to advocate the cultivation of this variety under dryland condition.

Table 1: Effect of *in-situ* moisture conservation practices, fertility levels and sorghum varieties on plant height (cm)

Treatments	First year						Second year					
	30 DAS	45 DAS	60 DAS	75 DAS	90 DAS	At harvest	30 DAS	45 DAS	60 DAS	75 DAS	90 DAS	At harvest
***In-situ* moisture conservation**												
M0 – farmer practices	21.1	51.0	85.4	155.0	172.0	173.4	21.0	49.5	84.2	150.2	165.3	166.7
M1 – Mo + Mulching	21.9	55.7	88.3	159.8	182.5	185.2	21.8	54.4	87.5	156.1	174.2	176.2
M2 – Mo + ridging & furrowing	22.1	56.2	88.9	158.3	180.2	182.5	22.0	55.1	88.1	154.4	171.3	173.6
M3 - Mo + ridging & furrowing + mulching	22.3	58.0	96.0	163.7	186.7	188.9	22.3	57.1	94.6	158.9	179.1	180.5
M4 – Mo + dhaincha mulching	25.9	53.4	85.7	156.7	175.0	178.9	24.3	52.3	85.3	153.0	168.9	170.5
S.E. (Mean) + -	0.22	0.36	0.63	0.86	1.50	2.16	0.25	0.40	0.77	1.51	2.18	1.26
C.D. (0.05)	0.71	1.17	2.06	2.78	4.90	7.04	0.83	1.30	2.51	4.93	7.13	4.13
Fertility levels (kg ha -1)												
F1- N40 P20 K20	21.5	52.5	86.7	155.7	176.3	178.7	21.4	51.1	85.9	151.8	168.9	170.5
F2 – N80 P30 K40	23.8	57.2	90.8	161.6	182.1	184.5	23.2	56.3	90.0	157.3	174.7	176.4
S.E, (Mean) + -	0.17	0.30	0.50	0.74	1.38	1.81	0.22	0.35	0.62	1.13	1.74	0.90
C.D. (0.05)	0.50	0.88	1.45	2.15	4.00	5.24	0.64	1.00	1.79	3.38	5.04	2.62
Sorghum varieties												
V1 – Varsha	22.2	52.2	86.4	168.7	203.3	209.1	21.9	51.0	85.5	164.3	194.2	198.4
V2 – CSV – 13	23.2	57.5	91.3	148.7	155.2	154.2	22.7	56.3	90.4	144.7	149.3	148.5
S.E. (Mean) + -	0.17	0.30	0.50	0.74	1.38	1.81	0.22	0.35	0.62	1.13	1.74	0.90
C.D. (0.05)	0.50	0.88	1.45	2.15	4.00	5.24	0.64	1.00	1.79	3.28	5.04	2.62

Table 2: Effect of *in-situ* moisture conservation practices, fertility levels and sorghum varieties on plant girth (cm)

Treatment	First year						Second year					
	30 DAS	45 DAS	60 DAS	75 DAS	90 DAS	At harvest	30 DAS	45 DAS	60 DAS	75 DAS	90 DAS	At harvest
***In-situ* moisture conservation practices**												
M0 – Farmer practices	4.69	5.78	6.34	6.62	6.83	6.94	4.71	5.69	6.24	6.46	6.75	6.86
M1 – Mo + Mulching	4.80	6.33	6.80	7.50	7.61	7.81	4.80	6.22	6.73	7.45	7.56	7.76
M2 – Mo + ridging & furrowing	4.87	6.48	6.39	7.54	7.69	7.92	4.84	6.37	6.67	7.49	7.61	7.82
M3 - Mo + ridging & furrowing + mulching	5.01	6.63	7.05	7.67	7.97	8.09	5.01	6.53	7.02	7.57	7.85	8.02
M4 – Mo + dhaincha mulching	4.59	5.74	6.37	7.24	7.31	7.50	4.57	5.67	6.35	7.05	7.25	7.42
S.E. (Mean) + -	0.07	0.06	0.07	0.08	0.08	0.07	0.07	0.10	0.07	0.18	0.16	0.07
C.D. (0.05)	0.24	0.19	0.21	0.25	0.26	0.21	0.22	0.32	0.21	0.60	0.54	0.22
Fertility levels (kg ha -1)												
F1- N40 P20 K20	4.69	6.05	6.57	7.07	7.31	7.49	4.69	5.96	6.46	6.95	7.21	7.40
F2 – N80 P30 K40	4.87	6.33	6.85	7.56	7.65	7.81	4.88	6.22	6.74	7.45	7.60	7.76
S.E, (Mean) + -	0.06	0.05	0.05	0.07	0.06	0.06	0.05	0.08	0.05	0.15	0.11	0.06
C.D. (0.05)	0.17	0.15	0.16	0.21	0.17	0.18	0.18	0.25	0.15	0.45	0.32	0.15
Sorghum varieties												
V1 – Varsha	4.71	6.16	6.74	7.35	7.53	7.78	4.73	6.04	6.63	7.26	7.45	7.69
V2 – CSV - 13	4.87	6.29	6.66	7.28	7.44	7.52	4.85	6.16	6.57	7.14	7.36	7.46
S.E. (Mean) + _ -	0.06	0.05	0.05	0.07	0.06	0.06	0.05	0.08	0.05	0.15	0.11	0.05
C.D. (0.05)	N.S.	N.S.	N.S.	N.S.	N.S.	0.18	N.S.	N.S.	N.S.	N.S.	N.S.	0.15

Table 3: Effect of *in-situ* moisture conservation practices, fertility levels and sorghum varieties on canopy development (%)

Treatment	First year				Second year			
	30 DAS	60 DAS	90 DAS	At harvest	30 DAS	60 DAS	90 DAS	At harvest
***In-situ* moisture conservation practices**								
M0 – Farmer practices	32.4	54.2	72.1	47.1	32.1	54.1	70.8	43.3
M1 – Mo + Mulching	33.1	59.7	77.6	52.7	33.0	59.6	77.0	49.5
M2 – Mo + ridging & furrowing	33.0	59.6	76.6	51.3	32.9	58.7	75.7	48.6
M3- Mo + ridging & furrowing + mulching	34.0	64.2	81.0	54.5	33.8	61.7	79.9	51.6
M4 – Mo + dhaincha mulching	31.9	56.5	74.0	51.2	31.4	55.4	72.6	45.7
S.E. (Mean) + -	0.25	0.38	0.38	0.22	0.22	0.22	0.51	0.33
C.D. (0.05)	0.82	1.23	1.23	0.71	0.73	0.71	1.67	1.09

Fertility levels (kg ha-1)								
F1- N40 P20 K20	31.9	56.7	74.1	49.7	31.7	55.7	72.8	45.8
F2 – N80 P30 K40	34.1	61.0	78.4	53.0	33.6	60.2	77.7	49.7
S.E, (Mean) + -	0.20	0.30	0.32	0.20	0.16	0.22	0.45	0.27
C.D. (0.05)	0.57	0.87	0.94	0.59	0.45	0.63	1.29	0.79
Sorghum varieties								
V1 – Varsha	32.3	57.6	77.3	52.2	32.0	56.7	76.2	48.8
V2 – CSV – 13	33.4	60.0	75.1	50.5	33.2	59.1	74.2	46.7
S.E. (Mean) + - _	0.20	0.30	0.32	0.20	0.16	0.22	0.45	0.27
C.D. (0.05)	0.57	0.87	0.94	0.59	0.45	0.63	1.29	0.79

Table 4: Effect of *in-situ* moisture conservation practices, fertility levels and sorghum varieties on root growth parameters

Treatment	No. of primary roots per plant		Dry wt. of root per plant (g)		Depth of roots (cm)	
	First year	Second year	First year	Second year	First year	Second year
***In-situ* moisture conservation practices**						
M0 – Farmer practices	75.5	71.7	25.5	23.2	50.3	53.4
M1 – Mo + Mulching	82.0	80.4	30.5	28.4	44.2	45.2
M2 – Mo + ridging & furrowing	80.1	78.0	29.9	27.1	47.2	48.0
M3 - Mo + ridging & furrowing + mulching	86.7	85.0	33.5	30.5	41.5	42.6
M4 – Mo + dhaincha mulching	77.5	76.2	27.8	25.5	47.0	46.7
Fertility levels (kg ha-1)						
F1- N40 P20 K20	75.7	73.7	27.8	25.1	43.3	45.2
F2 – N80 P30 K40	83.9	82.4	30.9	28.6	47.8	48.5
Sorghum varieties						
V1 – Varsha	84.0	81.9	30.8	28.3	47.3	48.7
V2 – CSV - 13	75.9	74.2	27.9	25.4	44.7	44.9

MCPs = Moisture Conservation Practices, FP = Farmer Practices

Table 5: Effect of *in-situ* moisture conservation practices, fertility levels and sorghum varieties on yield attributes

Treatments	First year					Second year				
	Wt. of panicle (g)	Length of panicle (cm)	Girth of panicle (cm)	No. of grains/ panicles	1000 grains wt. (g)	Wt. of panicle (g)	Length of panicle (cm)	Girth of panicle (cm)	No. of grains/ panicles	1000 grains wt. (g)
In-*situ* moisture conservation practices										
M0 – Farmer practices	61.9	19.4	18.1	2033	20.7	54.3	17.2	16.7	1855	20.5
M1 – Mo + Mulching	75.0	20.5	19.1	2421	22.0	69.5	18.3	17.6	2254	21.8
M2 – Mo + ridging & furrowing	74.4	202	18.9	2414	21.8	68.9	18.2	17.5	2248	21.7
M3 - Mo + ridging & furrowing + mulching	80.5	21.0	19.7	2531	22.6	74.9	18.8	18.1	2380	22.4
M4 – Mo + dhaincha mulching	69.9	19.9	18.6	2290	21.6	62.2	17.8	17.0	2052	20.9
S.E. (Mean) + -	0.39	0.19	0.14	20.91	0.14	0.39	0.22	0.22	17.08	0.17
C.D. (0.05)	1.26	0.63	0.45	68.91	0.45	1.28	0.71	0.71	55.69	0.55
Fertility levels (kg ha -1)										
F1- N40 P20 K20	68.6	19.7	18.4	2276	21.2	62.4	17.5	17.1	2091	21.0
F2 – N80 P30 K40	75.5	20.8	19.5	2398	22.3	69.5	18.7	17.7	2225	22.2
S.E, (Mean) + -	0.35	0.16	0.13	17.79	0.13	0.32	0.20	0.20	14.91	0.14
C.D. (0.05)	1.02	0.46	0,38	51.39	0.38	0.92	0.59	0.59	43.05	0.43
Sorghum varieties										
V1 – Varsha	73.5	18.5	21.6	2365	21.9	67.1	16.4	18.8	2181	21.7
V2 – CSV – 13	71.1	21.9	16.1	2310	21.6	64.8	19.7	15.9	2135	21.4
S.E. (Mean) +	0.35	0.16	0.13	17.79	0.13	0.32	0.20	0.20	14.91	0.14
C.D. (0.05)	1.02	0.46	0.38	51.39	N.S.	0.92	0.59	0.59	43.05	N.S.

Table 6: Effect of *in-situ* moisture conservation practices, fertility levels and sorghum varieties on biological, grain and stover yield and harvest index

Treatment	Biological yield (q/ha-1)			Grain yield (q/ha-1)			Stover yield (q/ha-1)			Harvest index		
	First year	Second year	Mean	First year	Second year	Mean	First year	Second year	Mean	First year	Second year	Mean
In-situ moisture conservation practices												
M0 – Farmer practices	104.11	80.75	92.43	23.61	18.22	20.91	80.49	62.52	71.50	22.73	22.59	22.66
M1 – Mo + Mulching	141.01	117.87	129.43	32.23	27.14	29.68	108.80	90.77	99.78	22.91	23.03	22.96
M2 – Mo + ridging & furrowing	137.17	115.32	126.24	31.34	26.47	28.80	105.82	88.85	97.33	22.92	22.98	22.95
M3- Mo + ridging & furrowing + mulching	151.42	132.87	142.14	34.73	30.62	32.67	116.69	102.27	109.48	22.98	23.06	23.13

M4 – Mo + dhaincha mulching	128.07	99.02	113.54	29.52	22.67	26.09	99.79	76.35	88.07	22.88	22.90	22.84
S.E. (Mean)+ -	3.62	3.03		0.57	0.76		2.53	2.46		0.198	0.131	
C.D. (0.05)	11.80	9.88		1.86	2.49		8.28	8.03		N.S.	N.S.	
Fertility levels (kg ha -1)												
F1- N40 P20 K20	119.53	98.73	109.13	27.56	22.49	25.02	92.67	76.23	84.45	22.83	22.78	22.81
F2 – N80 P30 K40	145.19	119.61	132.40	33.22	27.56	30.39	111.97	92.07	102.02	22.93	23.04	23.02
S.E, (Mean) + -	2.74	2.23		0.60	0.52		2.16	1.72		0.158	0.134	
C.D. (0.05)	7.91	6.44		1.75	1.52		6.25	4.98		N.S.	N.S.	
Sorghum varieties												
V1 – Varsha	141.38	116.18	128.78	31.45	25.88	28.66	110.53	90.31	100.42	22.09	22.22	22.19
V2 – CSV – 13	123.34	102.16	112.75	29.45	24.17	26.74	94.11	78.00	86.05	23.68	23.61	23.64
S.E. (Mean) + -	2.74	2.23		0.60	0.52		2.16	1.72		0.158	0.134	
C.D. (0.05)	7.91	6.44		1.75	1.52		6.25	4.98		0.456	0.309	

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