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Integrated use of nano nitrogen and moisture conservation practices for enhanced crop growth, water use and water use efficiency in *kharif* sorghum

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Abstract

A field experiment was conducted during the *kharif* seasons of 2024 and 2025 at the Soil Conservation and Water Management Farm, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur, Uttar Pradesh, India, to evaluate the effect of nano nitrogen fertilization and moisture conservation practices on the growth and yield of sorghum (*Sorghum bicolor* L. Moench). The experiment was laid out in a split-plot design with three replications, comprising six fertility levels in the main plots and four moisture conservation practices in the subplots. Growth, biomass accumulation, water use and water use efficiency were recorded at different crop growth stages. Application of 75% recommended dose of nitrogen (RDN) with 2 foliar sprays of 0.4% Nano N fertilizer (F_3) significantly improved crop performance over the control and other treatments recorded the highest plant height at 30 DAS (62.19 cm), 60 DAS (160.89 cm) and at harvest stage (212.00 cm). The treatment also recorded the maximum number of leaves plant⁻¹ at 60 DAS (15.69) and at harvest stage (13.12), fresh weight plant⁻¹ at 60 DAS (323.24 g) and harvest stage (825.09 g), and dry weight plant⁻¹ at 60 DAS (58.18 gram) and at harvest stage (318.83 gram). F_3 also recorded the highest water use (386.65 mm) and water use efficiency (7.53 kg seed ha⁻¹ mm⁻¹). Among moisture conservation practices, hydrogel @ 5.0 kg ha⁻¹ + organic residue mulch @ 5 t ha⁻¹ (M_3) resulted in superior crop growth and biomass accumulation, with maximum plant height at 30 DAS (60.36 cm), 60 DAS (155.25 cm) and at maturity (209.66 cm). The same treatment recorded the highest number of leaves plant⁻¹, fresh weight and dry weight at 30, 60 DAS and at maturity, along with the highest water use (398.72 mm) and water use efficiency (7.25 kg seed ha⁻¹ mm⁻¹). The results indicated that integrated application of reduced soil-applied nitrogen supplemented with Nano N foliar nutrition and effective moisture conservation through hydrogel and organic residue mulch enhanced crop growth, biomass production and water use efficiency in *kharif* sorghum.

Keywords: Sorghum, nano n fertilizers, hydrogel, plant growth, water use and water use efficiency

Introduction

Sorghum [*Sorghum bicolor* (L.) Moench] is the important crop in the country after rice, wheat maize and Pearl millets. Sorghum is not only staple food but it is also required to fulfil fodder requirement in order to make animal husbandry sector more viable. There is an urgent need to maintain well balanced and regular supply of more nutritious feed and fodder to animals in the state.

Sorghum, most popularly known in India as “Jowar” is often cross-pollinated crop and belongs to the family *Poaceae*. It is an important food, feed, fodder and ration for human, cattle and poultry. Its grain contains about 10-12% protein, 3% fat and 70% carbohydrate. Sorghum is the important crop in the country after rice, wheat maize and Pearl millets. Sorghum is not only staple food but it is also required to fulfil fodder requirement in order to make animal husbandry sector more viable. There is an urgent need to maintain well balanced and regular supply of more nutritious feed and fodder to animals in the state. It is an important food, feed, fodder and ration for human, cattle and poultry. Its grain contains about 10-12% protein, 3% fat and 70% carbohydrate. According to the USDA Production, Supply and Distribution Database, India's sorghum production during 2024–25 was estimated at about 6.0 million tonnes from nearly 4.0 million hectares with an average productivity of around 1.25 t ha⁻¹. State-wise sorghum statistics

indicated that Maharashtra accounted for about 1.546 million hectares area with 1.690 million tonnes production, followed by Karnataka with 0.648 million hectares area and 0.815 million tonnes production. Gangaiah. B. and Tara Satyavathi C. (2024)^[5]. Rajasthan occupied nearly 0.642 million hectares with production of about 0.520 million tonnes. Uttar Pradesh recorded comparatively higher productivity of approximately 1622 kg ha⁻¹, whereas Andhra Pradesh reported the highest productivity of about 3459 kg ha⁻¹ under irrigated conditions (Source: fas.usda.gov). India ranks fourth in total Sorghum production with 4.4 million tonnes grown in an area of 3.97 million hectares in 2023-24, where majority of Sorghum was produced during rabi season (source: fas.usda.gov). The *kharif* Sorghum (36.6%) was grown predominantly in Rajasthan (43.3%), Uttar Pradesh (15.6%), Haryana (10.1%) and Madhya Pradesh (9.8%), while rabi Sorghum (63.4%) grown in Maharashtra (63.5%), Karnataka (22%), Tamil Nadu (7.9%) and Andhra Pradesh (3.2%). Though the area under sorghum has declined from 18.6 M/ha in 1969-70 to 3.995 M/ha in 2024-25, its productivity has more than doubled (from 554 kg/ha to 1240 kg/ha) during the same period (Source: UPAG: Unified Portal for Agricultural Statistics, Ministry of Agriculture and Farmers Welfare), Government of India.

The reason for low productivity of this crop in agro-climatic zone IV a (Sub- Humid Southern Plain and Aravalli hills) seems to be non-adoption of proper agro techniques viz., using poor & old genotypes, inadequate use of fertilizer and inadequate plant population and plant protection measures. However, the production can be increased by adopting improved package including suitable genotype, optimum plant geometry and appropriate fertilization. Considering these facts, research efforts have been made to achieve substantial increase in sorghum productivity through evolving better genotypes development and dissemination of appropriate production technologies. But still a wide gap exists between realizable yield and yield obtained at the farmers' end.

Amongst growth factors, adequate supply of chemical fertilizer, especially N and P, is considered to be of prime importance due to its profound impact on various aspects of growth and development, hence productivity of crop depends on the balanced use of fertilizer and plays a key role in modernization of Indian agriculture and in making the country self-sufficient in food grain production. It is estimated that almost 35-40 per cent of the total food grain output can be directly attributed to fertilizer use. Combined application of conventional and nano fertilizers helped to increase growth, growth attributes like plant height, number of leaves, fresh weight, dry weight, water use and water use efficiency of sorghum. Nutrient content and uptake also showed higher values for the same treatment along with the nutrient use efficiency indices. Krishnamurthy *et. al.* (2023).

Since, the yield potential of a crop depends on its inherent capabilities along with extent to which it is being exploited through appropriate agro-techniques. Thus, there is a need to work out optimum combination of different growth factors so as to exploit the potential of these hybrid varieties under prevailing agro climatic conditions. Therefore, keeping this fact in view, this study was undertaken an experiment entitled: "Integrated Use of Nano Nitrogen and Moisture Conservation Practices for Enhanced Crop Growth, Water Use and Water Use Efficiency in *Kharif* Sorghum (*Sorghum bicolor* (L.) Moench)" conducted at Soil Conservation and Water Management Farm of Chandra Shekhar Azad Agriculture and Technology, Kanpur for experimental period of two consecutive *Kharif* season 2024 and

2025 with the following.

Materials and methods

Experimental Site and Soil Characteristics

The field experiment was conducted during the *kharif* season of 2023-2024 and 2024-2025. The investigation was completed at the Soil Conservation & Water Management Farm of the Chandra Shekhar Azad University of Agriculture & Technology located in Kanpur district is situated in the sub-tropical region of Uttar Pradesh in part of Gangetic alluvium, lying between the river Ganga and Yamuna. It covers 115 km from North to South and 105 km from East to West. It lies between 25° 26' and 26° 58' North latitude and 79° 31' and 80° 34' East longitude. The elevation of the farm of Chandra Shekhar Azad University of Agriculture & Technology, Kanpur is approximately 125.9 meters above Mean Sea Level. The average rainfall of the district is about 836 mm. The major portion of rainfall is received during the south west monsoon from the first week of July to the last week of November.

Experimental Design and Treatments

The experiment will be conducted using a Split Plot Design with 3 replications. While the full study has factors like fertility levels and moisture conservation practice this research conducted during *kharif* season 2024 and 2025. A total six fertility levels (Main plot) treatments were considered: F₁- Control, F₂-100% RDN through urea, F₃-75% RDN + 2 foliar spray of 0.4% Nano N fertilizer, F₄-75% RDN + 2 foliar spray of 2% urea fertilizer, F₅- 50% RDN + 2 foliar spray of 0.4% Nano N fertilizer, F₆- 50% RDN + 2 foliar spray of 2% urea fertilizer. Four moisture conservation practices (Sub plot) treatments viz. M₁- Control, M₂- Hydrogel @ 2.5 kg/ha + organic residue mulch 5 t/ha, M₃- Hydrogel @ 5.0 kg/ha + organic residue mulch 5 t/h and M₄- Kaolin @ 0.5% at 45 DAS spray.

The recommended dose of N, P and K for sorghum was 120:50:40 kg/ha. Application of seventy-five percentage through recommended dose of nitrogen, twenty five percent as application through nano N fertilizers and along with urea spray. The total phosphorus and potassic fertilizers as per recommended dose of fertilizers, was applied as a basal application, while the rest of the nitrogenous doses were applied in equal proportions during the vegetative and head initiation stages.

Result and discussion

Plant Height

At 30 DAS plant height was obtained under F₃-75% RDN + 2 foliar sprays of 0.4% Nano N fertilizer with 62.19 cm whereas the lowest plant height at 30 DAS was observed under F₁ control 57.32 cm. However, the differences among fertility levels at 30 DAS plant height were significant.

Plant height 60 DAS and at maturity stage was significantly recorded influenced through fertility levels during pooled basis. At 60 DAS, the highest plant height was observed under treatment F₃-75% RDN + 2 foliar sprays of 0.4% Nano N fertilizer with 160.89 cm, respectively, while the minimum plant height was recorded under F₁- Control with 146.85 cm, respectively. At maturity stage, the highest plant height was recorded under F₃ with 212.04 cm while the lowest was noticed under F₁ with 198.13 cm during pooled data basis respectively. Jadav *et. al.* (2025)^[6], Mehta and Bharat (2019)^[10].

At 30 DAS highest plant height was obtained under M₃- Hydrogel @ 5.0 kg ha⁻¹ + organic residue mulch @ 5 t ha⁻¹ with 60.36 cm, whereas the lowest plant height at 30 DAS was

observed under M_1 control 57.76 cm. However, the differences among moisture conservation practices at 30 DAS plant height were result significant. The plant height was significantly recorded by dissimilar moisture conservation practices during pooled data (Table 1). At 60 DAS, the maximum plant height was noted under treatment M_3 -Hydrogel @ 5.0 kg ha⁻¹ + organic residue mulch @ 5 t ha⁻¹ with 155.25 cm whereas M_1 -Control recorded the lowest values of 147.76 cm, respectively. At maturity time, the maximum plant height was noted under treatment M_3 -Hydrogel @ 5.0 kg ha⁻¹ + organic residue mulch @ 5 t ha⁻¹ with 209.66 cm, whereas M_1 -Control recorded the lowest plant height values noticed of 200.50 cm in respectively. Soni *et. al.* (2025), Srivastava *et. al.* (2023)^[12, 13].

Number of Leaves/ Plant

Number of leaves/plant 30 DAS was not significantly recorded influenced by fertility levels during both years (Table 2). At 30 DAS, the highest number of leaves/plants was observed under treatment F_3 -75% RDN + 2 foliar sprays of 0.4% Nano N fertilizer with 7.06 respectively, while the minimum number of leaves/plants was recorded under F_1 - Control with 6.12 respectively.

Number of leaves/plant 60 DAS and at maturity stage was significantly recorded influenced by fertility levels during both years (Table 2). At 60 DAS, the highest number of leaves/plants was observed under treatment F_3 -75% RDN + 2 foliar sprays of 0.4% Nano N fertilizer with 15.69, respectively, while the minimum number of leaves/plants was recorded under F_1 -Control with 10.41 respectively. At maturity stage, the highest number of leaves/plants was recorded under F_3 with 13.12, while the lowest was noticed under F_1 with 7.73 respectively. Udupudi *et. al.* (2024)^[14]

Number of leaves/plant 30 DAS was not significantly recorded influenced by moisture conservation practices during both years (Table 2). At 30 DAS, the highest number of leaves/plants was observed under treatment M_3 -Hydrogel @ 5.0 kg ha⁻¹ + organic residue mulch @ 5 t ha⁻¹ with 6.80 respectively, while the minimum number of leaves/plants was recorded under M_1 -Control with 6.24 respectively. The number of leaves/plants was significantly recorded by dissimilar moisture conservation practices during pooled data (Table 2). At 60 DAS, the maximum number of leaves/plants was noted under treatment M_3 -Hydrogel @ 5.0 kg ha⁻¹ + organic residue mulch @ 5 t ha⁻¹ with 14.01, whereas M_1 -Control recorded the lowest values of 10.78, respectively. At maturity stage, the maximum number of leaves/plants was noted under treatment M_3 -Hydrogel @ 5.0 kg ha⁻¹ + organic residue mulch @ 5 t ha⁻¹ with 11.33, whereas M_1 -Control recorded the lowest number of leaves/plant values noticed of 9.24, respectively. Sree *et. al.* (2024).

Fresh weight/plant (gram)

At 30 DAS, the maximum fresh weight/plant was noticed under F_3 -75% RDN + 2 foliar sprays of 0.4% Nano N fertilizer with (57.82 gram), whereas the lowest fresh weight/plant was observed under treatment F_1 - control (51.22 gram) in. However, the differences among fertility levels at the 30 DAS were non-significant. Fresh weight/plant 60 DAS and at maturity stage was significantly recorded influenced by fertility levels during both years (Table 3). At 60 DAS, the highest number of leaves/plants was observed under treatment F_3 -75% RDN + 2 foliar sprays of 0.4% Nano N fertilizer with (323.24 gram) respectively, while the minimum fresh/plants was recorded under F_1 - Control with (287.07 gram), respectively. At maturity stage, the highest fresh weight/plant was recorded under F_3 with

(825.09 gram), while the lowest was noticed under F_1 with (794.36 gram), respectively. Anil *et. al.* (2023)^[2], Srivastava, A., and Singh, R. (2023)^[13]

At 30 DAS, the maximum fresh weight/plant was noticed under M_3 -Hydrogel @ 5.0 kg ha⁻¹ + organic residue mulch @ 5 t ha⁻¹ with (58.94 gram) whereas the lowest fresh weight/plant was observed under treatment M_1 -Control (51.54 gram). However, the differences among moisture conservation practices at the 30 DAS were non-significant. At 60 DAS, the maximum fresh weight/plant was noticed under M_3 -Hydrogel @ 5.0 kg ha⁻¹ + organic residue mulch @ 5 t ha⁻¹ with (323.06 gram), whereas the lowest fresh weight/plant was observed under treatment M_1 -Control (284.40 gram). However, the differences among moisture conservation practices at 60 DAS were significant. At maturity stage, the highest fresh weight/plants were recorded under M_3 -Hydrogel @ 5.0 kg ha⁻¹ + organic residue mulch @ 5 t ha⁻¹ with (822.69 gram), while the lowest was noticed under M_1 -Control with (791.57 gram), respectively. However, the differences among moisture conservation practices at maturity stage were significantly. Ekinici *et. al.* (2014)^[4].

Dry weight/plant (gram)

At 30 DAS, the maximum dry weight/plant was noticed under F_3 -75% RDN + 2 foliar sprays of 0.4% Nano N fertilizer with (10.46 gram), whereas the lowest dry weight/plant was observed under treatment F_1 - control (9.07 gram) in. However, the differences among fertility levels at the 30 DAS were non-significant. Dry weight/plant 60 DAS and at maturity stage was significantly recorded influenced by fertility levels during both years (Table 3). At 60 DAS, the highest number of dry weight/plants was observed under treatment F_3 -75% RDN + 2 foliar sprays of 0.4% Nano N fertilizer with (58.18 gram) respectively, while the minimum fresh/plants was recorded under F_1 - Control with (52.27 gram), respectively. At maturity stage, the highest dry weight/plant was recorded under F_3 with (318.83 gram), while the lowest was noticed under F_1 with (286.40 gram), respectively. Anil *et. al.* (2023)^[2].

At 30 DAS, the maximum dry weight/plant was noticed under M_3 -Hydrogel @ 5.0 kg ha⁻¹ + organic residue mulch @ 5 t ha⁻¹ with (10.08 gram) whereas the lowest dry weight/plant was observed under treatment M_1 -Control (9.36 gram). However, the differences among moisture conservation practices at the 30 DAS were non-significant. At 60 DAS, the maximum dry weight/plant was noticed under M_3 -Hydrogel @ 5.0 kg ha⁻¹ + organic residue mulch @ 5 t ha⁻¹ with (57.82 gram), whereas the lowest dry weight/plant was observed under treatment M_1 -Control (52.64 gram). However, the differences among moisture conservation practices at 60 DAS were significant. At maturity stage, the highest dry weight/plants were recorded under M_3 -Hydrogel @ 5.0 kg ha⁻¹ + organic residue mulch @ 5 t ha⁻¹ with (316.85 gram), while the lowest was noticed under M_1 -Control with (288.42 gram), respectively. However, the differences among moisture conservation practices at maturity stage were significantly. Respectively Kundu and Chhabra (2023), Abera *et. al.* (2020)^[1, 9].

Water use and Water use efficiency

Among different fertility levels significantly influenced with respect to the water use and water use efficiency of sorghum during both years as well as on a pooled basis. Significantly, higher water use and water use efficiency was recorded with treatment F_3 - 75% RDN + 2 foliar spray of 0.4% Nano N fertilizer which is followed by treatment F_4 - 75% RDN + 2 foliar spray of 2% urea fertilizer than the rest of the other

fertility levels during both the years and pooled basis. The lowest water use and water use efficiency was noticed with treatment F₁- Control during both years and on a pooled basis. The highest values were (386.65 mm⁻¹) and (7.53 kg seed ha⁻¹mm⁻¹) in the pooled basis, respectively. The lowest values (330.89 kg seed ha⁻¹mm⁻¹) and (4.24 kg seed ha⁻¹mm⁻¹) were recorded with treatment, respectively on the pooled basis, respectively Katiyar *et al.*, (2021)^[8], Jakhar *et al.*, (2017)^[7]. It is evident from the results obtained during both years that the water use and water use efficiency recorded was influenced significantly due to different combination of moisture conservation practices during both years as well as a pooled basis. Significantly, higher water use and water use efficiency was recorded with treatment M₃- Hydrogel @ 5.0 kg/ha + organic residue mulch 5t/ha followed by M₂- Hydrogel @ 2.5 kg/ha + organic residue mulch 5t/ha than the rest of the during both the years and pooled basis. The lowest water use efficiency was noticed with treatment M₁-Control during the study of both years and on a pooled basis. The highest values were (398.72 mm) and (7.25 kg seed ha⁻¹mm⁻¹) in the year 2024 and (314.97mm) and (5.06 kg seed ha⁻¹mm⁻¹) recorded with the

treatment M₁-Control in the on the pooled basis. Giri *et al.*, (2025)^[16],

Conclusion

Overall, F₃ (75% RDN + two foliar sprays of 0.4% Nano N fertilizer) and M₃ (Hydrogel @ 5.0 kg ha⁻¹ + organic residue mulch @ 5 t ha⁻¹) consistently improved plant growth, biomass accumulation, water use and water use efficiency in sorghum. Thus, their integrated application can be recommended for enhancing growth and efficient water utilization under moisture-limited conditions.

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Table 1: Effect of fertility levels and moisture conservation practices on plant height (30, 60 DAS and at maturity stage) of sorghum.

Treatments	Plant height (cm)		
	At 30 DAS	At 60 DAS	At maturity stage
	Pooled	Pooled	Pooled
(A) Fertility levels: -6 (Main plot)			
F ₁ - Control	57.32	146.85	198.13
F ₂ - 100% RDN through urea	58.57	148.98	203.11
F ₃ - 75% RDN + 2 foliar spray of 0.4% Nano N fertilizer	62.19	160.89	212.00
F ₄ - 75% RDN + 2 foliar spray of 2% urea fertilizer	61.18	157.14	211.04
F ₅ - 50% RDN + 2 foliar spray of 0.4% Nano N fertilizer	59.83	153.70	209.23
F ₆ - 50% RDN + 2 foliar spray of 2% urea fertilizer	58.60	150.75	206.38
SE(d)±	1.07	2.75	3.76
CD at 5%	2.42	6.22	8.49
(B) Moisture Conservations:-4 (Subplot)			
M ₁ - Control	57.76	147.76	200.5
M ₂ - Hydrogel @ 2.5 kg/ha + organic residue mulch 5t/ha	60.11	154.76	208.31
M ₃ - Hydrogel @ 5.0 kg/ha + organic residue mulch 5t/ha	60.36	155.25	209.66
M ₄ - Kaolin @ 0.5% at 45 DAS spray	60.16	154.44	208.12
SE(d)±	0.79	2.04	2.73
CD at 5%	1.62	4.16	5.57

Table 2: Effect of fertility levels and moisture conservation practices on No. of leaves/plant at 60 DAS and at maturity stage of sorghum

Treatments	No. of leaves/plant		
	At 30 DAS	At 60 DAS	At maturity stage
	Pooled	Pooled	Pooled
(A) Fertility levels: -6 (Main plot)			
F ₁ - Control	6.12	10.41	7.73
F ₂ - 100% RDN through urea	6.38	11.89	9.88
F ₃ - 75% RDN + 2 foliar spray of 0.4% Nano N fertilizer	7.06	15.69	13.12
F ₄ - 75% RDN + 2 foliar spray of 2% urea fertilizer	6.87	14.43	11.71
F ₅ - 50% RDN + 2 foliar spray of 0.4% Nano N fertilizer	6.64	12.94	11.23
F ₆ - 50% RDN + 2 foliar spray of 2% urea fertilizer	6.53	11.65	10.25
SE(d)±	0.37	0.56	0.36
CD at 5%	NS	1.26	0.81
(B) Moisture Conservations:-4 (Subplot)			
M ₁ - Control	6.24	10.78	9.24
M ₂ - Hydrogel @ 2.5 kg/ha + organic residue mulch 5t/ha	6.73	13.43	11.06
M ₃ - Hydrogel @ 5.0 kg/ha + organic residue mulch 5t/ha	6.80	14.01	11.33
M ₄ - Kaolin @ 0.5% at 45 DAS spray	6.63	13.11	10.98
SE(d)±	0.28	0.52	0.34
CD at 5%	NS	1.07	0.69

Table 3: Effect of fertility levels and moisture conservation practices on fresh weight /plant (gram) of sorghum.

Treatments	fresh weight /plant (gram)		
	At 30 DAS	At 60 DAS	At maturity stage
	Pooled	Pooled	Pooled
(A) Fertility levels: -6 (Main plot)			
F ₁ - Control	51.22	287.07	794.86
F ₂ - 100% RDN through urea	55.44	296.90	803.32
F ₃ - 75% RDN + 2 foliar spray of 0.4% Nano N fertilizer	57.82	323.24	825.09
F ₄ - 75% RDN + 2 foliar spray of 2% urea fertilizer	56.87	319.66	822.38
F ₅ - 50% RDN + 2 foliar spray of 0.4% Nano N fertilizer	56.45	301.51	807.83
F ₆ - 50% RDN + 2 foliar spray of 2% urea fertilizer	55.56	298.57	803.08
SE(d)±	4.27	10.72	14.185
CD at 5%	NS	24.21	28.79
(B) Moisture Conservations:-4 (Subplot)			
M ₁ - Control	51.54	284.40	791.57
M ₂ - Hydrogel @ 2.5 kg/ha + organic residue mulch 5t/ha	55.97	305.52	813.28
M ₃ - Hydrogel @ 5.0 kg/ha + organic residue mulch 5t/ha	58.94	323.06	822.69
M ₄ - Kaolin @ 0.5% at 45 DAS spray	55.79	304.99	810.15
SE(d)±	3.28	7.74	11.67
CD at 5%	NS	15.76	23.78

Table 4: Effect of fertility levels and moisture conservation practices on Dry weight /plant (gram) of sorghum.

Treatments	Dry weight/plant (gram)		
	At 30 DAS	At 60 DAS	At maturity stage
	Pooled	Pooled	Pooled
(A) Fertility levels: -6 (Main plot)			
F ₁ - Control	9.07	52.27	286.40
F ₂ - 100% RDN through urea	9.61	53.00	290.43
F ₃ - 75% RDN + 2 foliar spray of 0.4% Nano N fertilizer	10.46	58.18	318.83
F ₄ - 75% RDN + 2 foliar spray of 2% urea fertilizer	10.18	57.05	312.59
F ₅ - 50% RDN + 2 foliar spray of 0.4% Nano N fertilizer	9.98	55.67	305.07
F ₆ - 50% RDN + 2 foliar spray of 2% urea fertilizer	9.86	54.58	2.99.09
SE(d)±	0.69	1.0	5.49
CD at 5%	NS	2.25	12.38
(B) Moisture Conservations:-4 (Subplot)			
M ₁ - Control	9.36	52.64	288.42
M ₂ - Hydrogel @ 2.5 kg/ha + organic residue mulch 5t/ha	10.04	55.06	301.70
M ₃ - Hydrogel @ 5.0 kg/ha + organic residue mulch 5t/ha	10.08	57.82	316.85
M ₄ - Kaolin @ 0.5% at 45 DAS spray	9.95	54.98	301.29
SE(d)±	0.52	0.73	4.03
CD at 5%	NS	1.49	8.20

Table 5: Effect of various treatments on water use and water use efficiency on *kharif* sorghum.

Treatments	Water Use (mm)	Water Use efficiency (kg seed ha ⁻¹ mm ⁻¹)
	Pooled	Pooled
(A) Fertility levels: -6 (Main plot)		
F ₁ - Control	330.89	4.24
F ₂ - 100% RDN through urea	350.53	6.12
F ₃ - 75% RDN + 2 foliar spray of 0.4% Nano N fertilizer	386.65	7.53
F ₄ - 75% RDN + 2 foliar spray of 2% urea fertilizer	377.51	7.01
F ₅ - 50% RDN + 2 foliar spray of 0.4% Nano N fertilizer	369.94	6.50
F ₆ - 50% RDN + 2 foliar spray of 2% urea fertilizer	357.89	6.45
(B) Moisture Conservations:-4 (Subplot)		
M ₁ - Control	314.97	5.06
M ₂ - Hydrogel @ 2.5 kg/ha + organic residue mulch 5t/ha	385.17	6.67
M ₃ - Hydrogel @ 5.0 kg/ha + organic residue mulch 5t/ha	398.72	7.25
M ₄ - Kaolin @ 0.5% at 45 DAS spray	350.08	6.15

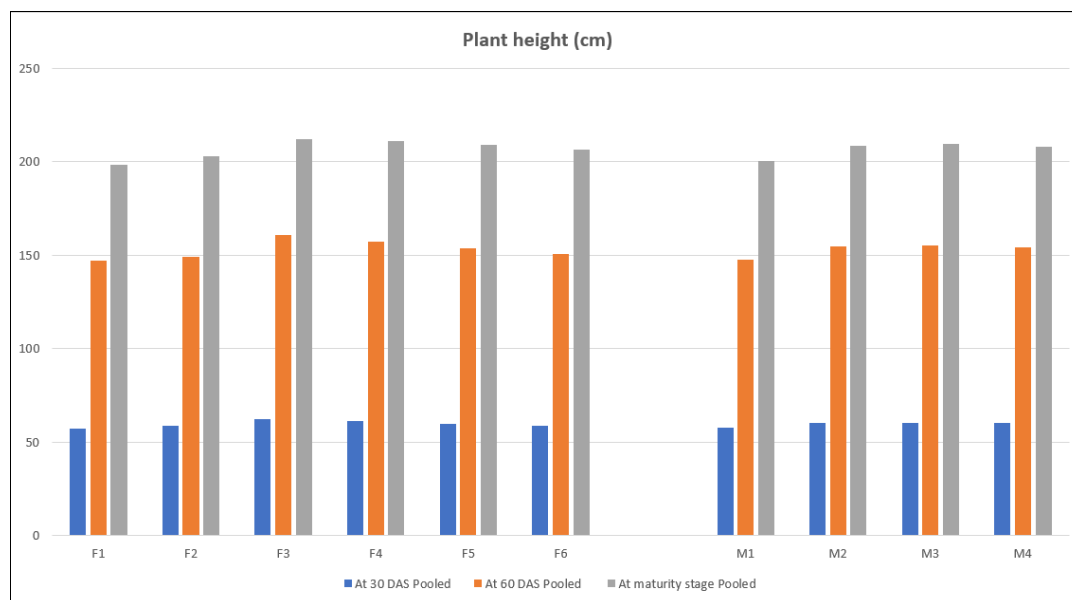


Fig 1: Effect of fertility levels and moisture conservation practices on plant height (30, 60 DAS and at maturity stage) of sorghum.

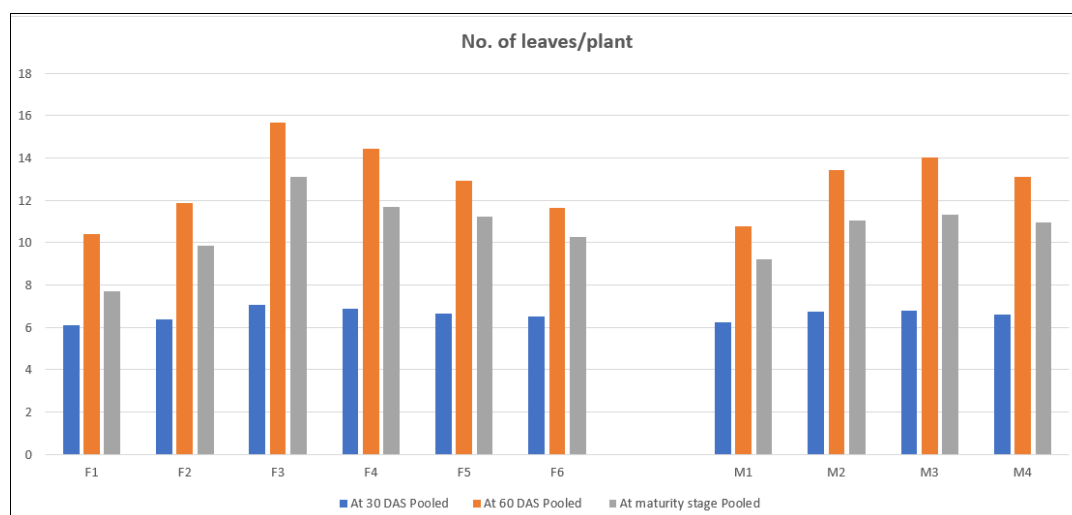


Fig 2: Effect of fertility levels and moisture conservation practices on No. of leaves/plant at 60 DAS and at maturity stage of sorghum.

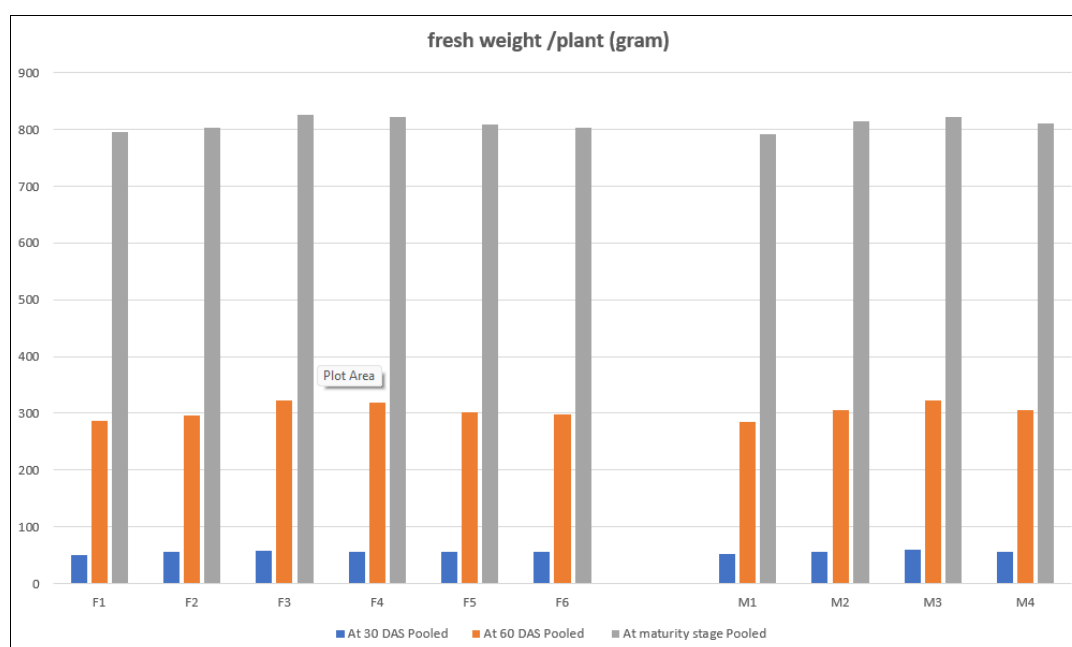


Fig 3: Effect of fertility levels and moisture conservation practices on fresh weight /plant (gram) of sorghum

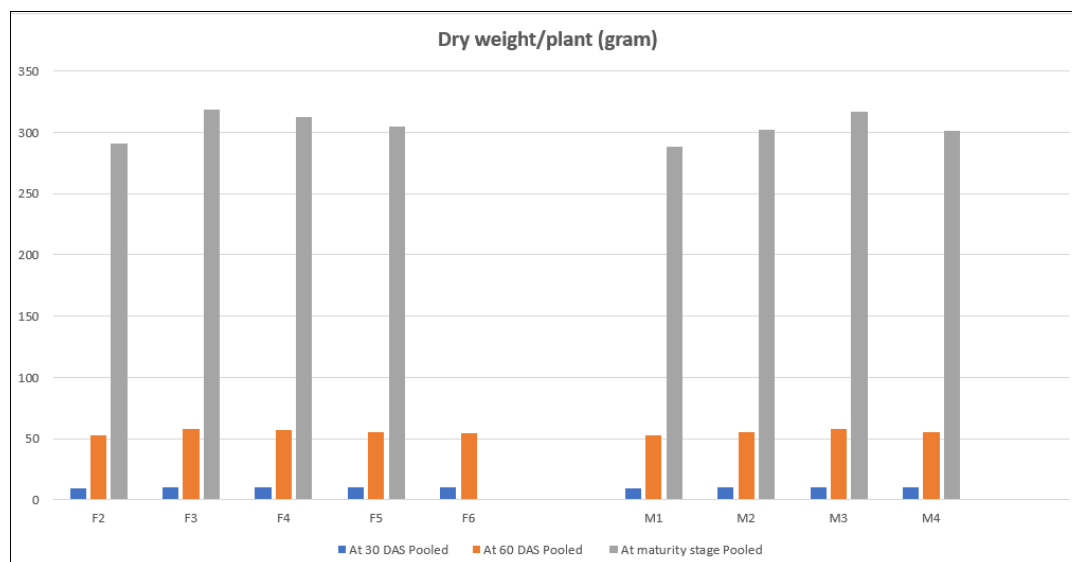


Fig 4: Effect of fertility levels and moisture conservation practices on Dry weight /plant (gram) of sorghum

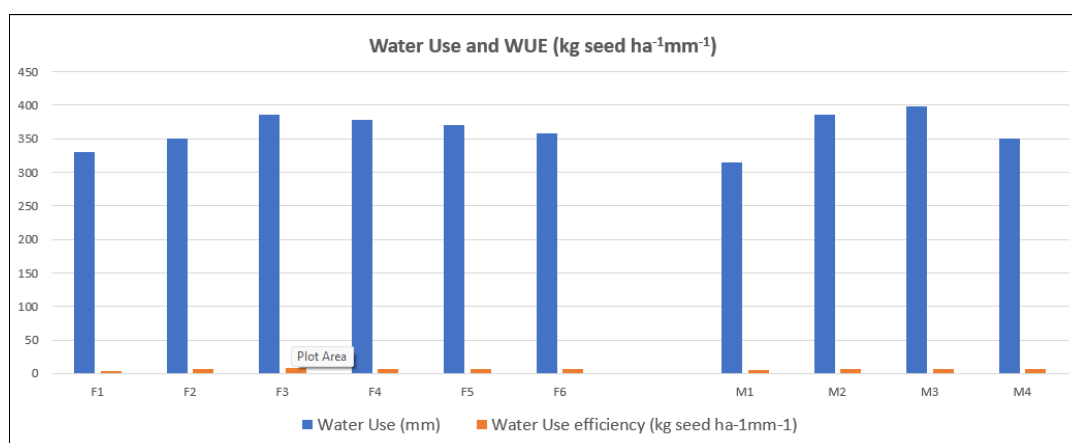


Fig 5: Effect of fertility levels and moisture conservation practices on water use and water use efficiency on *kharif* sorghum

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