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Determination of optimum irrigation scheduling under IW:CPE ratio and FYM interaction for chickpea

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Abstract
Irrigation is an essential agricultural practice for food, pasture and fiber production in semi-arid and arid areas. Agricultural irrigation is tremendous importance to global food security. This research purpose was to determine optimum irrigation scheduling under IW:CPE ratio and FYM interaction for chickpea which was grown with three irrigation levels include 0.4 IW:CPE ratio (I_1), 0.6 IW:CPE ratio (I_2) and 0.8 IW:CPE ratio (I_3) and two FYM levels include no FYM and 10 t ha^{-1} FYM application. Chickpea should be irrigated at 0.6 IW:CPE ratio with 10 t ha^{-1} FYM application to achieve higher growth rate and yield for chickpea variety GG-5. However, if FYM is not available than chickpea should be irrigated at 0.8 IW:CPE ratio. In 0.8 IW:CPE ratio, soil moisture was conserved 3 to 4% more by applying FYM than without FYM treatment while 2 to 3% and 1 to 2% moisture in 0.6 IW:CPE ratio and 0.4 IW:CPE ratio, respectively.

Keywords: Chickpea, irrigation, irrigation water, cumulative pan evaporation (IW: CPE) ratio, Soil moisture, farm yard Manur

1. Introduction
The globally growing demand for water has ushered the need for its efficient and judicial utilizations in all fields and agriculture in particular being a single largest consumer of water (Gontia & Tiwari, 2008) [1]. The majority of irrigation methods in India perform at a very low efficiency, which calls for application of efficient water management technologies for meeting the increasing water demands. Irrigation is an essential agricultural practice for food, pasture and fiber production in semi-arid and arid areas. Agricultural irrigation is tremendous importance to global food security. However, irrigated agriculture faces tremendous uncertainty in water supply due to prolong drought associated with climate change as well as increased competition from environmental, municipal and industrial water need.
Water is considered as the most critical resource for sustainable development. Seeds and fertilizers fail to achieve their full potential if plants are not optimally watered. Water is the most scarce and costly in the semi-arid tropics. It is necessary to utilize irrigation water most judiciously and efficiently. This could be possible by scheduling proper quantity of irrigation water by modifying some other factors.
There is necessity to develop irrigation strategies for better water use efficiency without affecting quality of yield. This requires monitoring water status of the plant frequently to properly manage irrigation. Irrigation scheduling method is usually categorized on soil, plant and meteorological basis (Tekelioglu *et al*., 2017) [8]. Irrigation scheduling based upon crop water status can be more advantageous since crops react to both the soil and aerial environment (Yazar *et al*., 1999) [10]. Efficient irrigation and nutrient management holds the key for enhancing chickpea production under irrigated condition. In semiarid region water scarcity and moisture stress are the major factors limiting chickpea production.
More research is needed to optimize the irrigation scheduling method for applying proper quantity of irrigation water by modifying some other factors which enhance soil moisture. Therefore, the aim of this study is to determine optimum irrigation scheduling under different IW: CPE ratio and FYM interaction for chickpea.

2. Materials and Methods
A field experiment was conducted on the Agronomy farm of B. A. College of Agriculture, AAU, Anand during *rabi* season of the year 2019 – 2020. The research farm is located at the latitude of 22°35’ N and longitude of 72°55’ E. The elevation of the farm is 45.1 m above mean sea level. The climate of Anand is semi-arid and sub-tropical.

The soil of the experimental field is representative of the soil of the region and is loamy sand soil which is popularly known as 'Goradu soil'. The soil is light brown in colour and alluvial in origin. The field has good drainage capacity and fairly water holding capacity. The field experiment was laid out on chickpea (*Cicer arietinum* L.) cultivar Gujarat Gram 5 (GG 5) with split plot design involved three irrigation level (I_1: 0.4 IW:CPE ratio, I_2: 0.6 IW:CPE ratio & I_3: 0.8 IW:CPE ratio) and two FYM level (F_1: No FYM, F_2: 10 t ha^{-1} FYM) with four replication. 10 t ha^{-1} FYM was broadcasted uniformly before 8 days of sowing to better decompose in 12 plots based on treatment combination. Fertilizers were applied as 20 kg nitrogen and 40 kg phosphorus in furrows as basal from ammonium sulphate and DAP. Sowing was done on 14th November, 2019 at a depth of about 5 cm by drilling method with seed rate 60 kg ha^{-1} and keeping 45 cm space between row.

The first irrigation was applied in all the plots just after sowing the seeds to ensure uniform and better germination. Thereafter, Irrigation was imposed to concerned experimental plots according to the irrigation schedules based on IW:CPE ratio of the respective treatment. Irrigation water was applied as per decided IW:CPE ratio of 0.8, 0.6 and 0.4 level. A fixed depth of 50 mm irrigation water was applied when cumulative pan evaporation value reached 62.5 mm (0.8), 83.33 mm (0.6) and 125 mm (0.4). The cumulative pan evaporation values were calculated from daily pan evaporation measured with the help of USWB class 'A' open pan evaporimeter installed at meteorological observatory, which was in the proximity of the experimental plot. The quantity of irrigation water applied in surface flooding was measured by 7.5 cm head parshall flume. A fixed depth of 50 mm irrigation water was applied to each treatment at irrigation based on IW:CPE ratio of 0.8, 0.6 and 0.4, respectively. The detail regarding dates of irrigation in different treatments along with number of irrigation and total quantity of water applied are given in Table 1.

Table 1: Treatment wise irrigation calendar during *rabi* 2019 – 2020

Treatment/ No of Irrigation	I_1 (0.4 IW:CPE)	I_2 (0.6 IW:CPE)	I_3 (0.8 IW:CPE)
Common	14/11/2019	14/11/2019	14/11/2019
1	30/12/2019	15/12/2019	07/12/2019
2	08/02/2020	14/01/2020	30/12/2019
3		09/02/2020	22/01/2020
4			09/02/2020
No. of Irrigation	(2 + 1) = 3	(3 + 1) = 4	(4 + 1) = 5
Quantity of Irrigation water (mm)	150	200	250

Soil moisture observations were taken by gravimetric method at every alternate day. The soil samples of all the treatments were collected at 0930 hours to find out soil moisture at 0 – 22.5 cm and 22.5 – 45 cm depth. Soil sample was collected by using soil auger from the plot. The soil samples were transferred immediately into the labeled cans. The cans were covered with the lid and taped immediately. Fresh weight of the sample was measured by weighing balance before placing it in oven for 48 h at temperature between 100 – 110 °C (105 °C) or till getting constant weight. The dry sample was reweighted to calculate the soil moisture content. The soil moisture was determined by using the equation (1).

$$\text{Soil moisture (\%)} = \frac{\text{Weight of moist soil - Weight of dry soil}}{\text{Weight of dry soil}} \times 100 \quad (1)$$

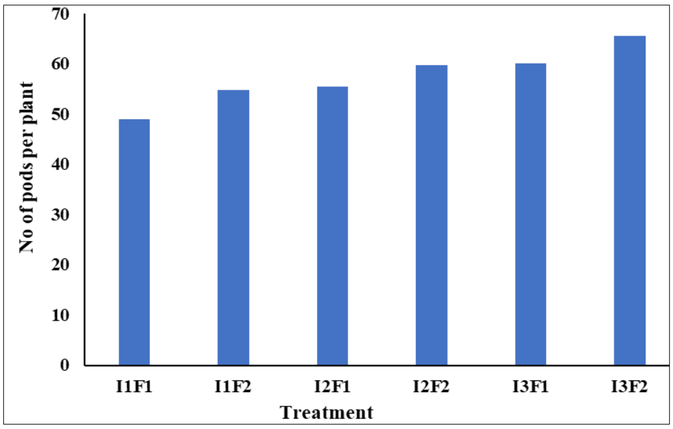
3. Results and Discussion

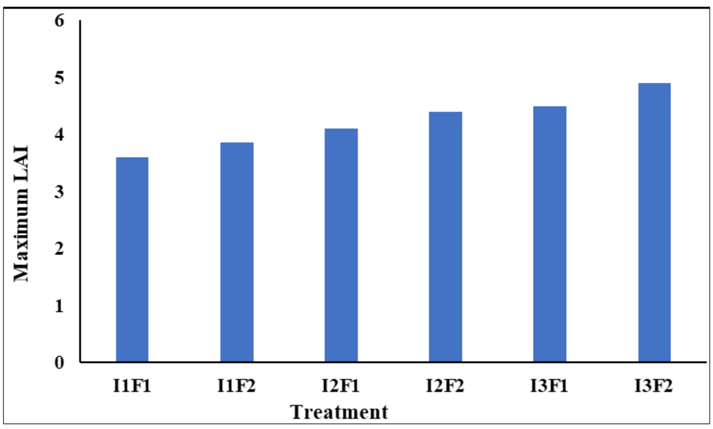
3.1 Optimization of Irrigation Scheduling under different IW:CPE ratio and FYM interaction

When plants are under water stress causes stomatal closure, which decline photosynthesis and trigger metabolic changes. This situation should have to improve by FYM application with better irrigation scheduling because application of FYM considerably improves soil physical properties and nutrient uptake resulting in increased yield and yield component. Similar results were found by Ndiso *et al.* (2018) [5] and Lourduraj (2000) [2]. This could be due to reduction in canopy temperature and optimum available soil moisture.

Optimum irrigation scheduling under IW:CPE ratio and FYM interaction evaluated based on response of chickpea growth, yield and yield component. The data concerned with no of pod per plant, maximum leaf area index, plant height, straw yield and seed yield are depicted graphically in Fig. 1.

The analyzed data indicated that all growth parameter, yield and yield attributes were significantly affected by different IW:CPE ratio and FYM interaction. Plant height (67), maximum leaf area index (4.9) and number of pods per plant (65.5) were observed higher value under 0.8 IW:CPE ratio with 10 t ha^{-1} FYM application (I3F2) and the lowest value was recorded under 0.4 IW:CPE ratio without FYM application (I1F1). The results were in good conformity with the findings of Lourduraj (2000) [2], Mustafa *et al.* (2008) [4] Mansur *et al.* (2010) [3], Srinivasulu *et al.* (2016) [7], Patil *et al.* (2017) [6] and Ndiso *et al.* (2018) [5]. Among different irrigation levels with both FYM levels, 0.8 IW:CPE ratio (I_3) was followed by 0.6 IW:CPE ratio (I_2) and 0.4 IW:CPE ratio (I_1) but highest under 10 t ha^{-1} FYM application.





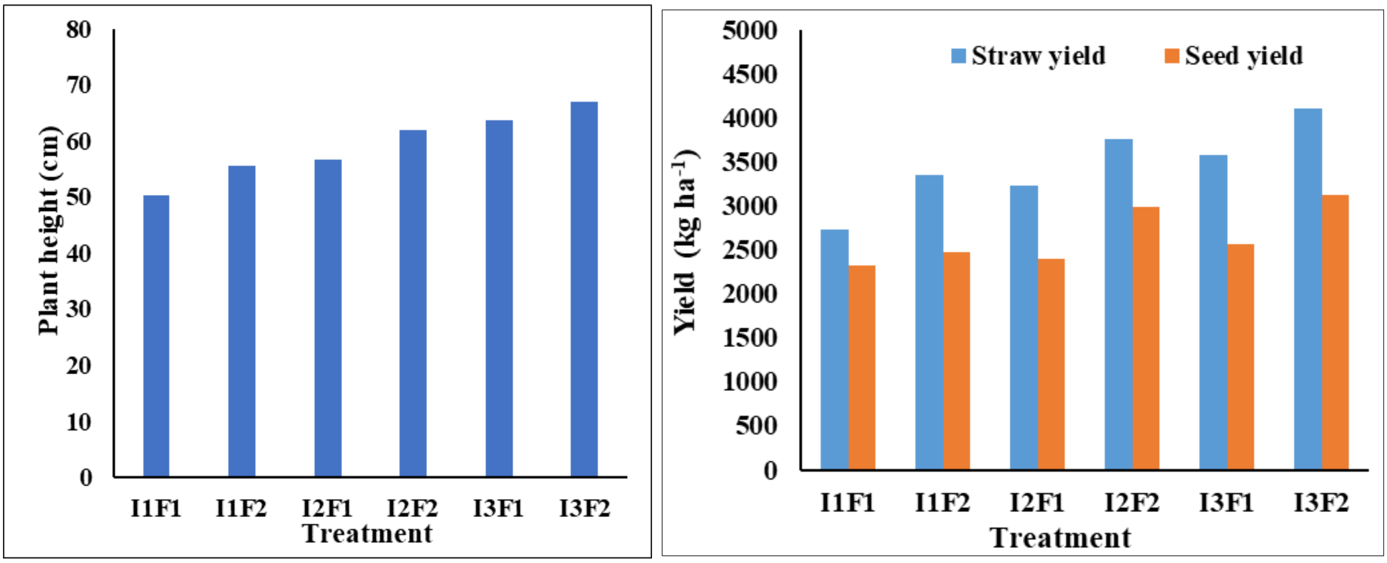


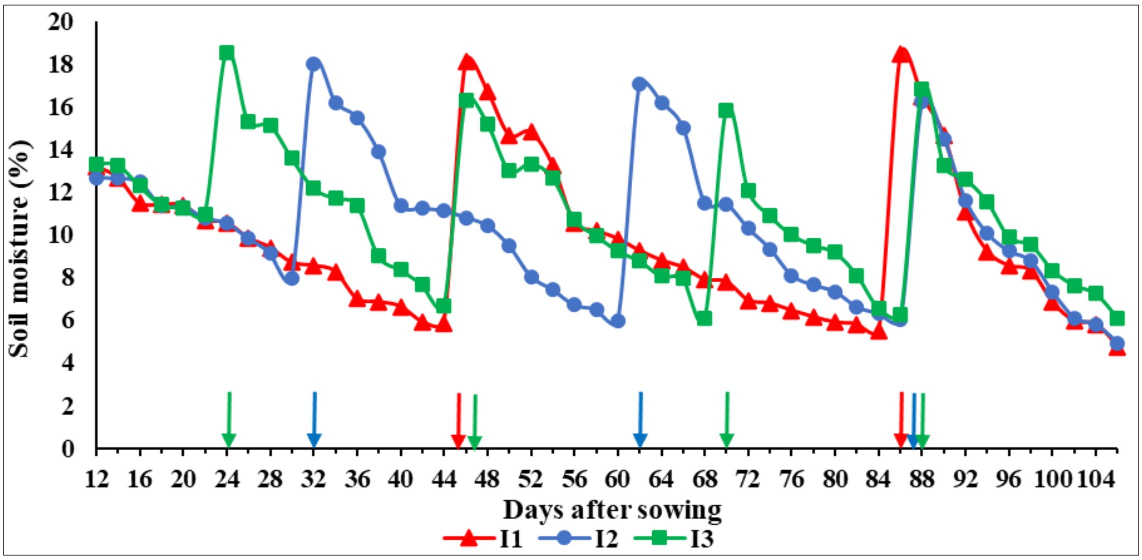
Fig 1: Effect of irrigation scheduling based on IW:CPE ratio and FYM interaction on (a) no of pods per plant (b) maximum leaf area index (c) plant height(d) straw yield and seed yield

3.2 Soil moisture content under different irrigation levels

The alternate day soil moisture depletion trend under three irrigation levels in different FYM levels are depicted graphically in Fig. 2 (a) and (b). Irrigation levels showed their marked effect on soil moisture. There was no distinct change observed in soil moisture during initial period of crop growth under both FYM levels. When first irrigation was applied at 24 DAS in I_3 treatment, 32 DAS in I_2 treatment and 46 DAS in I_1 treatment, soil moisture increased to field capacity. Soil moisture was not much more decreased in I_3 treatment compared to I_2 treatment and I_1 treatment with 10 t ha^{-1} and no FYM application. This could be attributed to frequent irrigation was applied with short interval which is directly related to non-stress condition.

In I_1 treatment, second irrigation was applied at grain filling stage (86 DAS) when soil moisture drastically dropped and close to permanent wilting point (5.50%) under without FYM application while soil moisture was only decreased up to 7.10% with 10 t ha^{-1} FYM application at 84 DAS. Soil moisture stress was observed in I_1 treatment because lower moisture content was observed during reproductive stage of chickpea for long period which resulted increase canopy temperature and decrease stomatal conductance. Moisture stress has prominent effect on leaf area, dry matter accumulation and limiting the no of pods in I_1 treatment.

In I_3 treatment soil moisture varied between 16.30% to 6.10% under without FYM condition and 17.09% to 7.65% under 10 t ha^{-1} FYM application when second irrigation was applied at the time of first irrigation of I_1 treatment so, soil moisture was decreased with same trend in both the treatment. There was observed more or less similar trend of decreasing soil moisture of I3F1 treatment (15.86% to 6.26%), I3F2 (17.07% to 7.62%) with I2F1 treatment (17.05% to 5.59%), I2F2 (18.42% to 7.60%) after irrigated at pod development stage (70 DAS) and flowering stage (62 DAS) respectively. Soil moisture was decreased at the end of the growing season due to temperature increase and beginning of maturity.



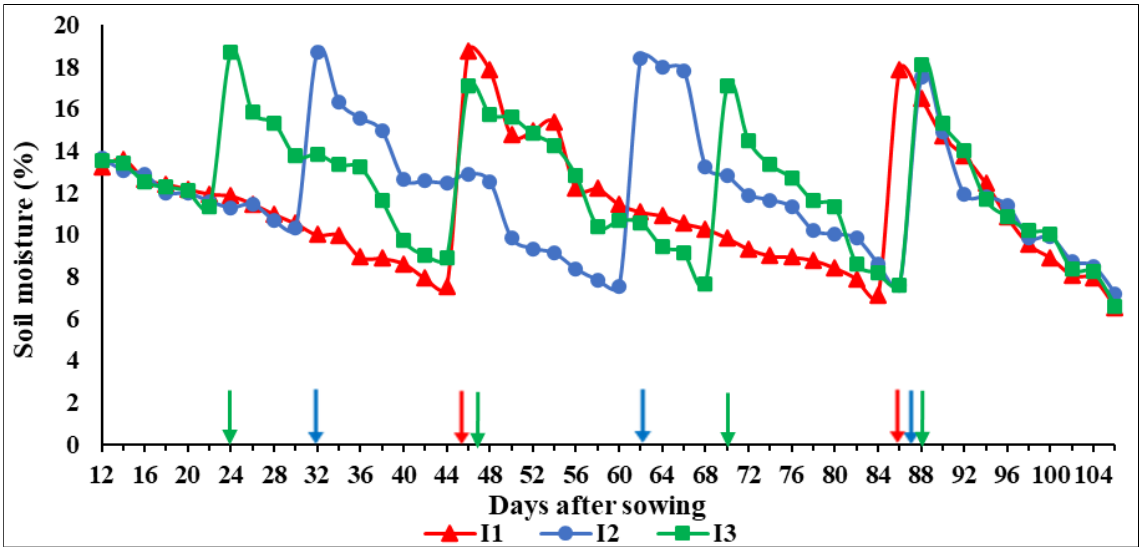
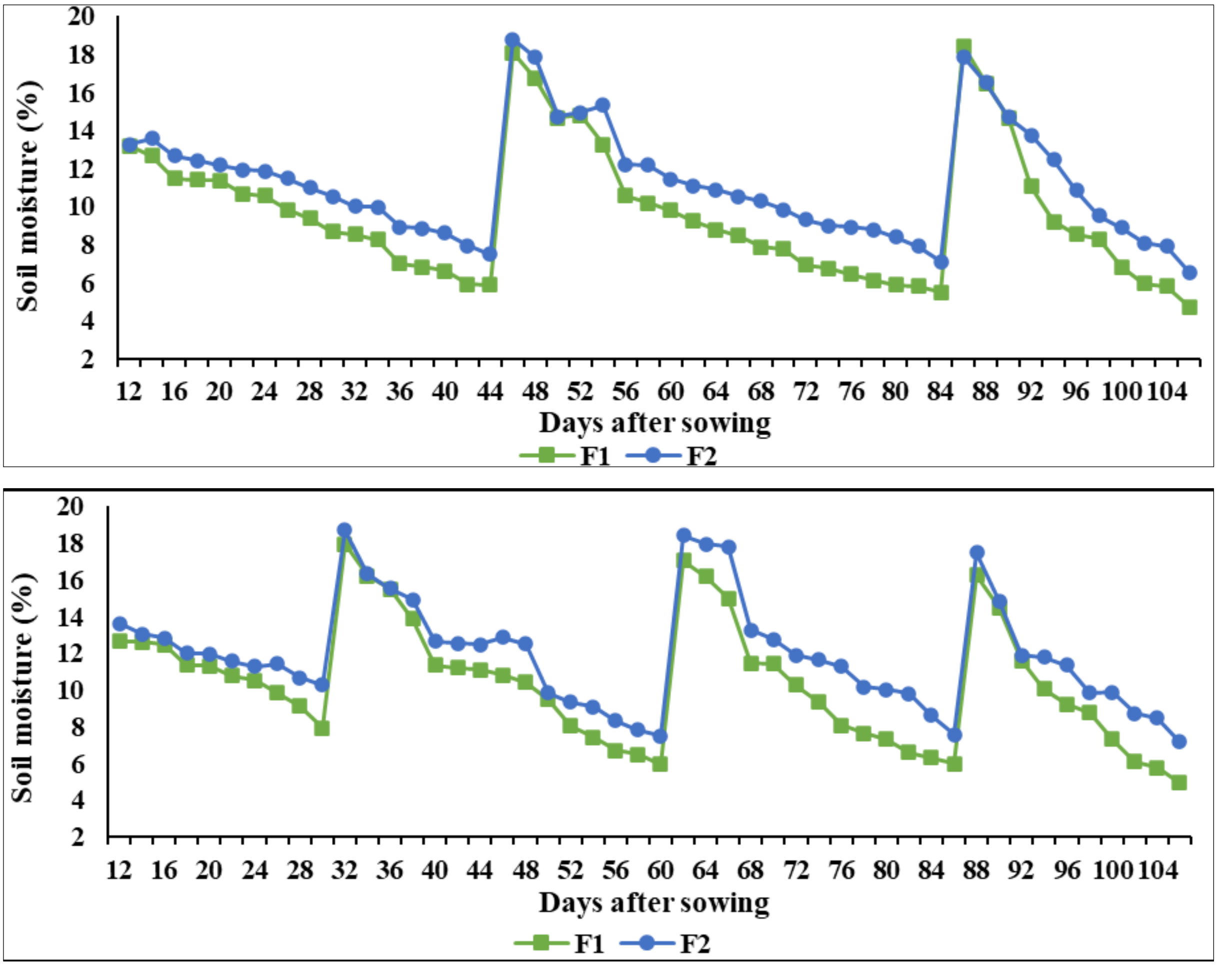


Fig 2: Effect of irrigation levels on soil moisture content under different FYM levels (a) No FYM (b) 10 t ha^{-1} FYM during crop growth period

3.3 Soil moisture content under different FYM levels

The alternate day soil moisture depletion pattern under two FYM levels in different irrigation levels are illustrated graphically in Fig. 3 (a), (b) and (c). There was no marked difference between without FYM treatment and 10 t ha^{-1} FYM application during emergence phase (upto 22 DAS) under all the irrigation levels due to less vegetative growth. Soil moisture difference was clearly noticed between without FYM treatment and 10 t ha^{-1} FYM application in I_1 treatment which was followed by I_2 treatment and I_3 treatment. In I_1 treatment, soil moisture was conserved 3 to 4% more by applying FYM than without FYM treatment while 2 to 3% and 1 to 2% moisture in I_2 and I_1 irrigation levels, respectively. This could be accounted for application of FYM considerably improves physical properties and helps to maintain high relative plant water content under soil moisture stress condition. Farmyard manure application significantly increased moisture content was also reported by Ndiso *et al*. (2018) [5] and Wang *et al*. (2016) [9].



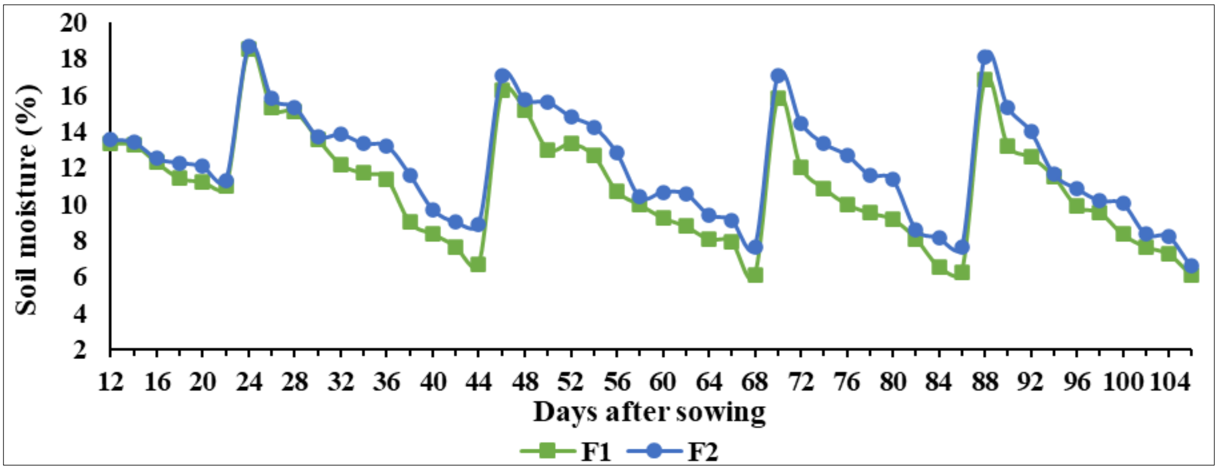


Fig 3: Effect of FYM levels on soil moisture content under different irrigation levels (a) 0.4 IW:CPE ratio (b) 0.6 IW:CPE ratio (c) 0.8 IW:CPE ratio during crop growth period

4. Conclusions

In conclusion, optimal irrigation management plays a crucial role in enhancing the growth rate and yield of chickpea variety GG-5. The study suggests that irrigating chickpea at a 0.6 IW:CPE ratio, coupled with a 10t ha^{-1} application of farm yard manure (FYM), is the most effective approach for achieving higher productivity. In the absence of FYM, a 0.8 IW:CPE ratio is recommended. It was observed that the inclusion of FYM in the 0.8 IW:CPE ratio resulted in a notable conservation of soil moisture, with an increase of 3 to 4% compared to the treatment without FYM. Similarly, the 0.6 IW:CPE ratio with FYM application retained 2 to 3% more moisture, and the 0.4 IW:CPE ratio with FYM conserved 1 to 2% more moisture. These findings shows the importance of integrated irrigation and organic amendments, particularly FYM, in optimizing water use efficiency and promoting sustainable chickpea cultivation practices.

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6. References

1. Gontia NK, Tiwari KN. Development of crop water stress index of wheat crop for scheduling irrigation using infrared thermometry. Agric. Water Manag. 2008;95:1144-1152.
2. Lourduraj CA. Effect of irrigation and manure application on the growth and yield of groundnut. Acta Agron Hung. 2000;48(1):83-88.
3. Mansur CP, Palled YB, Halikatti SI, Chetti MB, Salimath PM. Pattern of leaf area, canopy width and dry matter production in chickpea as influenced by dates of sowing and irrigation levels. Karnataka J Agric. Sci. 2010;23(4):635-637.
4. Mustafa MN, Sagar GK, Chandrika V, Reddy PM. Growth and yield of chickpea as influenced by irrigation and nutrient management. Legume Res Int. J. 2008;31(3):221-223.
5. Ndiso JB, Chemining’wa GN, Olubayo FM, Saha HM. Effects of different farmyard manure levels on soil moisture content, canopy temperature, growth and yield of maize – cowpea intercrops. J Adv Stud Agric. Biol. Environ Sci. 2018;5:5-21.
6. Patil DD, Nayak MK, Patel HR. Effect of dates of sowing and irrigation levels on yield and yield attributing characters of chickpea. Int. J Agric. Sci. 2017;9:4220-4221.
7. Srinivasulu DV, Solanki RM, Naveen Kumar NB, Bhanuprakash M, Vemaraju A. Effect of irrigation based on IW:CPE ratio and sulphur levels on yield and quality of gram (*Cicer arietinum* L.). Legume Res. 2016;39(4):601-604.
8. Tekelioglu B, Buyuktas D, Bastug R, Karaca C, Aydinsakir K, Dinc N. Use of crop water stress index for irrigation scheduling of soybean in Mediterranean conditions. J Exp. Agric. Int. 2017;18(6):1-8.
9. Wang X, Jia Z, Liang L, Yang B, Ding R, Nie J, Wang J. Impacts of manure application on soil environment, rainfall use efficiency and crop biomass under dryland farming. Sci Rep. 2016;6:20994.
10. Yazar A, Howell AT, Dusek DA, Copeland KS. Evaluation of crop water stress index for LEPA irrigated corn. Irrig. Sci. 1999;18:171-180.
11. Kondapalli AS, Lavanya GR. Induced chemical mutagen in m1 generation of chickpea (*Cicer arietinum* L.).