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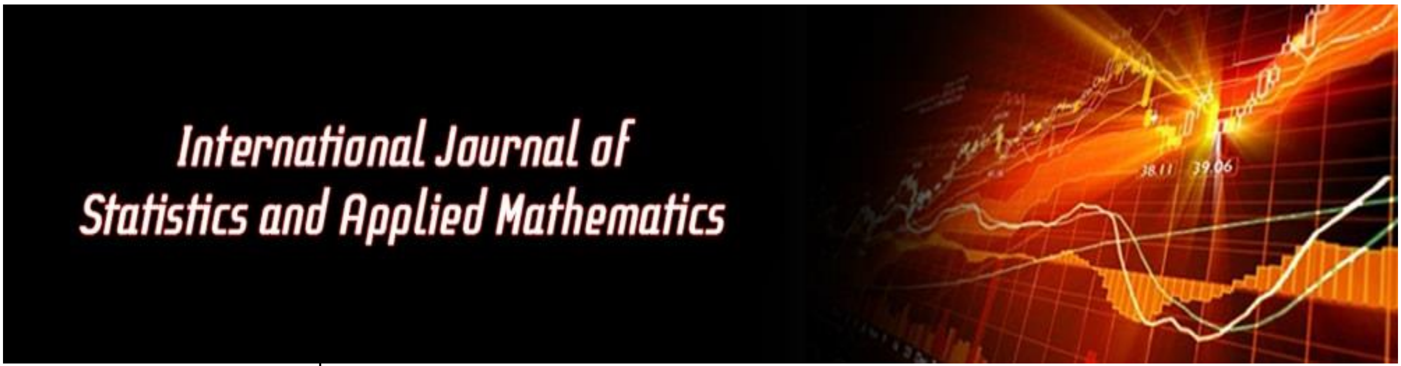

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Effect of maize and chickpea intercropping under the different row ratios on soil moisture depletion

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Abstract
An experiment was laid out to study the effect of maize and chickpea intercropping under the different row ratios on soil moisture depletion at Agronomy farm, B. A. College of Agriculture, AAU, Anand (Gujarat), India during the *rabi* season of the year 2021-2022. The soil of the experimental field was loamy sand. The objective was to determine the effect of maize and chickpea intercropping and row ratios on soil moisture depletion. The experiment was laid out in a Randomized Block Design with six treatments replicated four times. The treatments details are T_1: Sole maize, T_2: Sole chickpea, T_3: Maize paired row, T_4: Maize + chickpea (1: 1), T_5: Maize + chickpea (1: 2), T_6: Maize + chickpea (2: 2). During the initial stages of crop growth, the primary cause of moisture loss was evaporation from the soil surface. Greater drop in soil moisture of the deeper layer (30 to 45 cm) was observed in intercropping treatments, particularly those that had a higher proportion of chickpea rows.

Keywords: Maize, chickpea, intercropping, row ratios, soil moisture

Introduction
Next to rice and wheat, maize (*Zea mays* L.) is the third most important cereal crop, with the highest production potential among cereals. Due to its high photosynthesis efficiency owing to the C_4 mechanism, maize produces a high biological yield as well as grain yield in a short period of time, achieving it the title of "Queen of Cereals."
After beans and peas, chickpeas (*Cicer arietinum* L.) are the world's third-largest pulse crop. It is a significant semi-arid tropics pulse crop, especially in India's rainfed ecosystem. Chickpea is a Fabaceae family legume crop. By retaining atmospheric nitrogen in their root nodules, chickpea can improve soil fertility and maintain soil productivity. Chickpea is also known as the "King of Pulses" because it contains 21.1% protein, 61.5% carbohydrates, and 2.2% oil (Gupta, 1988) [5].
In comparison to other cropping systems, intercropping is a good approach for higher yield, growth, and development (Patel *et al.* 1984) [7]. The purpose of intercropping is generally to increase the total productivity per unit area per unit time by growing multiple crops in the same field, with the main objective is efficient utilization of environmental resources (Dhillon *et al.* 1979) [3]. Intercropping minimizes the risk of total crop failure in the event of a serious disease infestation or insect pest attack and scarcity of resources because two or more crops are cultivated on the same field.

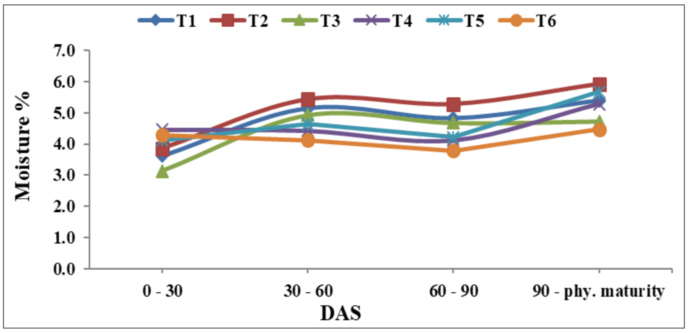
Materials and Methods
A field experiment was conducted on the Agronomy farm of B. A. College of Agriculture, AAU, Anand. The research farm is located at the latitude of 22°35' N and longitude of 72°55' E. The altitude of the farm is 45.1 m above the mean sea level. The experiment was laid out in a Randomized Block Design with six treatments replicated four times. The treatments details are T_1: Sole maize, T_2: Sole chickpea, T_3: Maize paired row, T_4: Maize + chickpea (1: 1), T_5: Maize + chickpea (1: 2), T_6: Maize + chickpea (2: 2). The soil at the experiment location was sandy loam in type and typical of that found in the Charotar region of Gujarat, which includes Anand. Locally, this soil is known as "Goradu Soil." The variety for maize is "Gujarat Anand Yellow Maize Hybrid 3" (GAYMH 3) and for chickpea, Gujarat Junagadh Gram 6 (GJG 6) was used. After field preparation, the layout of the experiment was laid out. Fertilizers were applied as per the recommendation for maize and chickpea crops 150-40-00 NPK kg ha^{-1} and 25-50-00 NPK kg ha^{-1} respectively through urea and diammonium phosphate (DAP).

Half quantity of nitrogen and full quantity of phosphorus was applied in furrows as basal dose. After applying the basal dose of fertilizer in the rows, sowing was done at a depth of about 5 cm by dibbling method with a seed rate of 20 kg ha^{-1} for maize and 60 kg ha^{-1} for chickpea crops. The first irrigation was given immediately after sowing to ensure uniform and better establishment of the crop. Thereafter, irrigation was applied according to the critical stages of the crops. Thinning and gap filling were done to maintain 20 cm and 10 cm intra-row spacing for maize and chickpea, respectively. To eliminate weeds from the field, weeding was frequently done and intercultural operation was carried out by wheel hoe for better aeration to plant roots. The soil moisture content was measured with a gravimetric method. Soil samples were taken from a single replication of each treatment for 0-15 cm, 15-30 cm, and 30-45 cm soil depths using a soil auger at 7-day intervals. The soil samples were immediately placed in labeled cups and weighed before and after oven drying at 105 °C for 72 hours or until a consistent weight was achieved. The following equation was used to calculate the soil moisture percentage (on a weight basis):

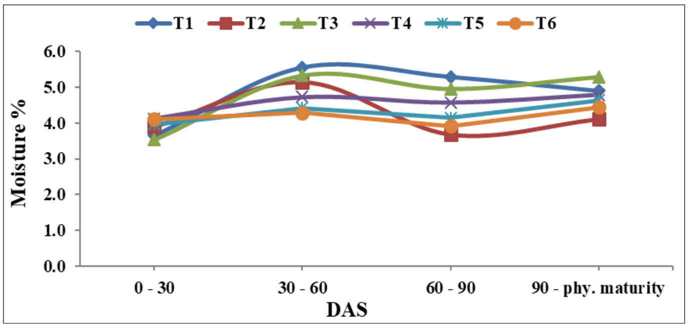
$$\text{Percent soil moisture} = \frac{\text{weight of wet soil} - \text{weight of dry soil}}{\text{weight of dry soil}} \times 100$$

Results and Discussions

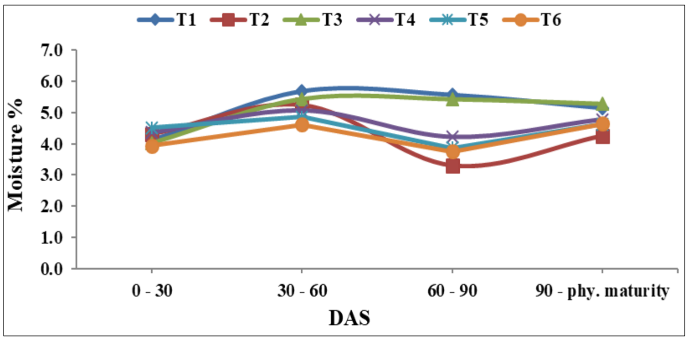
Soil moisture depletion was influenced significantly by different row ratios recorded at 0-30, 30-60, 60-90 DAS and 90-physiological maturity. Data regarding soil moisture % depicted in Figure 1.



A. [0-15 cm]



B. [15-30 cm]



C. [30-45 cm]

Fig 1: Effect of different row ratio treatments on soil moisture % at 0-15 cm, 15-30 cm and 30-45 cm depth

Because there was little transpiration from the crop plants in the early growth phases, the amount of soil moisture lost by transpiration in all treatments was negligible. The primary cause of moisture loss during the initial stages of crop growth was evaporation from the soil surface. Because evaporation started fast from the surface after irrigation, the values for the soil moisture % at the upper layer (0-15 cm) were low in all treatments. The widely spaced rows like maize paired row and sole maize showed more moisture loss from the 0-15 cm layer during 0-30 DAS, but at the 15-30 cm and 30-45 cm depths, moisture lost in each treatment was not noticeably different. Because the canopy was still developing and did not entirely cover the soil, the treatments with wide spacing may have allowed more radiation to reach at ground level, directly affecting the top layer of soil. The deeper layer (15-45 cm) is affected by transpiration since the roots haven't yet reached those layers and plants haven't developed their canopies as much. Only surface evaporation had an impact on the loss of soil moisture. Our findings are supported by Singh *et al.* (2000) [8] who came to the conclusion that the crop extracted more soil moisture from the top 0-15 cm soil layer in both monoculture and intercropping systems. This may be because there was more soil moisture available in the upper layers and the maximum root biomass was present in this soil profile. Choudhary *et al.* (2013) [2] observed that maize paired row planting with soybean resulted in the maximum soil moisture extraction in the 0-15 cm layer.

Less soil moisture was lost throughout the 30-60 and 60-90 DAS periods than during the 0-30 DAS period. This occurred because the soil surface was extensively covered by crops during this time, which led to less radiation penetrating the soil and lowered evaporation. The percentage of soil moisture loss was lower than those in the early stages, even though transpiration was responsible for a relatively greater amount of soil moisture loss.

In the deeper layer (30 to 45 cm) observed that intercropping treatments, particularly those that had a higher proportion of chickpea rows, showed a greater drop in soil moisture. During 60-90 DAS and 90-physiological maturity, there was a greater drop in soil moisture at deeper layers in the case of sole chickpea and intercropping. The tap root system of chickpea may be the cause of that. In conditions of moisture stress in the upper layer, roots are therefore more able to reach deeper layers of soil in search of moisture than maize crops. Our findings are in good agreement with those of Krishnamurthy *et al.* (1996) [6], who claimed that during the entire growth period, chickpeas had the ability to use water up to a soil depth of 120 cm. According to Ali *et al.* (2005) [1] soil water depletion in the 30-45 and 45-60 cm become rapid after 30 DAS, indicating that the uptake of water in these soil layer by roots did not occur until that time, although some roots might have reached these soil depths at this stage. The intercropping system depleted more moisture from deeper layers than maize paired row and sole maize. Because both crops absorbed more moisture during the crop period in the intercropping system than in a sole crop, the rate of moisture use and consumption were higher. Similar findings were reported by Goswami *et al*. in (2002) [4] in pearl millet based intercropping.

Conclusion

During the initial stages of crop growth, the primary cause of moisture loss was evaporation from the soil surface. Because evaporation started fast from the surface after irrigation, the values for the soil moisture% at the upper layer (0-15 cm) were low in all treatments. During 30-60 and 60-90 DAS loss of soil moisture was less as compared to 0-30 DAS because the soil was fully covered by crops during this time, which led to less radiation penetrating the soil and lowered evaporation. Greater drop in soil moisture of deeper layer (30 to 45 cm) was observed in intercropping treatments, particularly those that had a higher proportion of chickpea rows. The tap root system of chickpea may be the cause of that.

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