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Effect of Moisture Regimes on Yield Attributes, Yield, Nutrient Uptake and Quality of Chickpea Cultivars (*Cicer arietinium* L.)

D. Swetha* and S.A. Hussain

Department of Agronomy, College of Agriculture, Acharya N.G. Ranga Agricultural University, Rajendranagar, Hyderabad - 500 030, Telangana, India
**Corresponding author*

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A B S T R A C T

The present investigation entitled “Effect of moisture regimes on yield attributes, yield, nutrient uptake and quality of chickpea (*Cicer arietinum L.*)” were carried out at College Farm, College of Agriculture, Rajendranagar, Hyderabad. Among moisture regimes, Irrigation scheduled at 0.6 IW: CPE (I_3) produced significantly higher yield attributes and grain and haulm yields of chickpea but it was on par with 0.9 IW: CPE (I_4). The JG-11 variety has produced higher grain yield than Annegiri. Among nutrient uptake, N, P and K uptake was more in 0.6 IW: CPE (I_3) but it was on par with 0.9 IW: CPE (I_4) and significantly superior as compared to I_1 (Rainfed) and I_2 (0.3 IW: CPE) while, varieties did not differ significantly in respect of NPK uptake. Protein content was recorded significantly superior in 0.9 IW: CPE (I_4) it was on par with 0.6 IW: CPE (I_3). The varieties have no influence on protein content.

Introduction

Pulses are commonly known as food legumes which are secondary to cereals in production and consumption in India. Pulses are the most valuable and naturally occurring sources of protein, vitamins, minerals and calories. Pulses play an important role in Indian agriculture as they restore soil fertility by fixing atmospheric nitrogen (approximately 20 kg ha^{-1}) through their nodules. Some pulses are drought resistant and some are having erosion resisting property due to their deep root system and good ground coverage. Because of these good characters, pulses are called as ‘marvel of nature’ (Parihar and Sandhu, 1987).

Chickpea (*Cicer arietinum L.)* is one of the most important grain legumes and belongs to the family Leguminosae. It is a drought tolerant leguminous crop used in various foods in several developing countries including India as a source of highly digestible (70-90%) dietary protein. Water is a crucial input for augmenting crop production towards sustainability in agriculture. Scientific water management aims to provide suitable soil moisture environment to the crop to obtain optimum yield commensurate with maximum economy in irrigation water and maintain soil productivity.

Availability of moisture in the soil enhances the efficiency of applied nutrients. Any reduction of soil moisture at critical stages will considerably reduce the grain yield. Therefore, it is necessary to evaluate irrigation scheduling so as to realize highest yield attributes, yield, nutrient (NPK) uptake and quality parameter (protein) of chickpea cultivars.

Materials and Methods

A field experiment was conducted to during *rabi,* 2013-2014. The research work was carried out at College Farm, College of Agriculture, Rajendranagar, Hyderabad. The soil of the experimental field was sandy loam in texture with pH of 7.8. The soil was low in available nitrogen (226 kg ha^{-1}), available phosphorus (18.5 kg ha^{-1}) and medium in available potassium (235 kg ha^{-1}) contents. The experiment was laid out in a randomized block design (two factors) with one factor I: treatments of four moisture regimes *viz.*, I_1 (Rainfed), I_2 (0.3 IW: CPE), I_3 (0.6 IW: CPE), I_4 (0.9 IW: CPE) and factor II: varieties JG-11 and Annegiri and replicated thrice. Chickpea was sown after treating the seed with Rhizobium and were hand dibbled @ 2 seeds $hill^{-1}$ at a depth of 6 cm and sowing was carried out in N-S direction leaving 10 cm space between two hills with a row to row gap of 30 cm. Immediately after sowing basal application of N-20, P_2O_5-50, K_2O-40 kg ha^{-1} was applied. Intercultural operations like weeding, irrigation, pruning, disease and insect management were done as per necessary.

Nitrogen content in grain samples of chickpea were estimated by modified micro Kjeldahl method after digesting the powdered plant sample with H_2SO_4 and H_2O_2 (Piper, 1966).This nitrogen content of grain samples was multiplied with a factor 6.25 and protein content of grain samples of chickpea was obtained (Piper, 1966).

The tri-acid digested plant samples were analysed for phosphorus content by Vanado - molybdo phosphoric acid yellow colour method. The intensity of yellow colour developed was measured using Spectronic – 20 D. The uptake of phosphorus was calculated by multiplying the phosphorus content with the respective dry matter production and expressed in kg ha^{-1}.

Potassium content of the diluted tri-acid digest was determined by using ELICO flame photometer and the uptake of potassium was estimated by multiplying the K content with the respective dry matter production and presented in kg ha^{-1}.

Yield attributes and yield were recorded at harvest. The data recorded were statistically analyzed duly following the analysis of variance technique for randomized block design as suggested by Panse and Sukhatme (1978).

Results and Discussion

The present investigation entitled “Effect of moisture regimes on yield attributes, yield, nutrient uptake and quality of chickpea (*Cicer arietinum L*.)” were carried out during *rabi*, 2013-2014 at College Farm, College of Agriculture, Rajendranagar, Hyderabad. The results of the investigation, regarding the chickpea on yield attributes, yield, NPK uptake and protein content have been presented in tables 1, 2 and 3.

Yield attributes

The maximum number of pods $plant^{-1}$ (74.27 and 65.30 for JG-11 and Annegiri, respectively) was recorded with I_3 (0.6 IW: CPE) treatment, whereas the lowest number of pods $plant^{-1}$ (53.20 and 46.25 for JG-11 and Annegiri, respectively) was recorded under I_1 (control). A further increase in the moisture regime failed to influence the number of pods plant^{-1} from 0.6-0.9 IW: CPE ratio as supported with results of Patel *et al.,* (1988) and Mansur *et al.,* (2010). This could be ascribed to the fact that moisture availability in the root zone increased the nutrient uptake which produces multiple physiological effects and to increase in net assimilation followed by source to sink of the photosynthates. Similar findings were reported by Singh and Dixit (1992), Dixit *et al.,* (1993), Dabhi *et al.,* (1998), Reddy and Ahlawat (1998), Kaushik and Chaubey (1999), Chandrasekhar and Saraf (2005) and Mustafa *et al.,* (2008). The varieties significantly influenced the number of pods plant^{-1}. All the treatments differed significantly among themselves. I_3 (74.27 pods plant^{-1} of JG-11) recorded highest number of pods which is at par with I_4 treatment (70.17 pods plant^{-1} of JG-11), while I_1 put forth the lowest number of pods (53.20 pods plant^{-1} of JG-11). JG-11 recorded significantly higher pods (74.27 pods plant^{-1}) when compared with Annegiri (61.52 pods plant^{-1}). Similar findings were reported by Naik *et al.,* (2012) and Rao *et al.,* (2012).

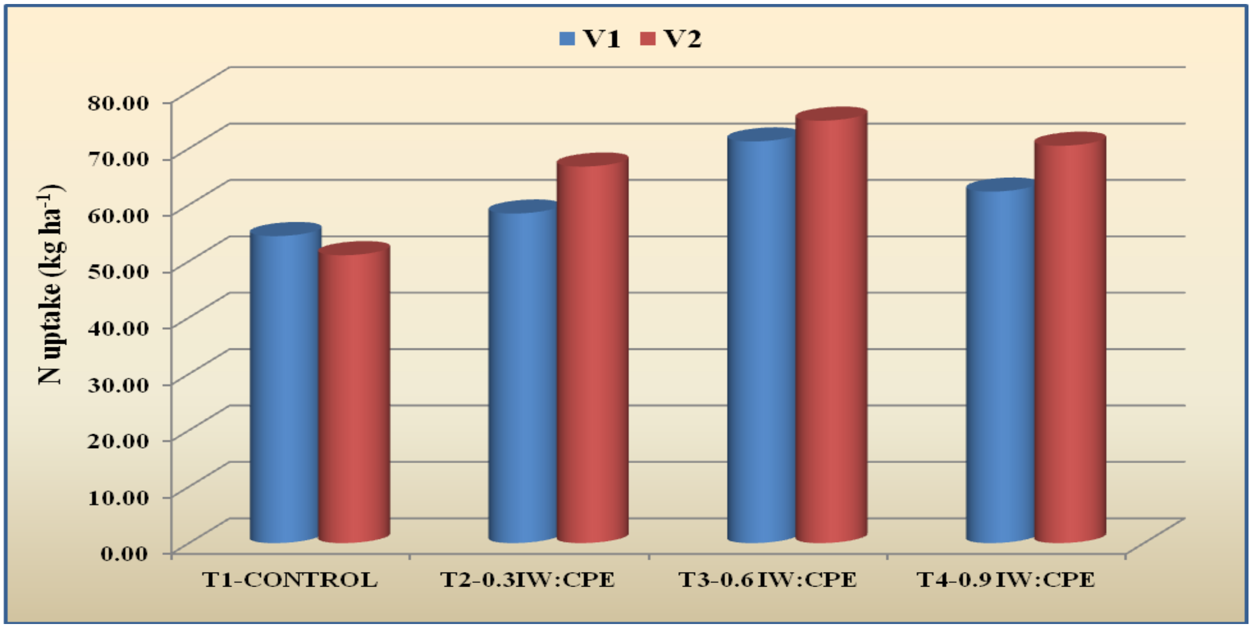
No.of seed pod^{-1} in chickpea showed that irrigation schedules, varieties and their interactions have no significant effect. These results are in conformity with those of Dixit *et al.,* (1993), Reddy and Ahlawat (1998), Kaushik and Chaubey (1999), Chandrasekhar and Saraf (2005).

Irrigation treatment I_3 recorded significantly higher test weight (24 g and 20.83 g for JG-11 and Annegiri, respectively) as compared to the rest of the irrigation treatments and was followed, in decreasing order, by I_4 (23.84 g and 20.2 g for JG-11 and Annegiri, respectively), I_2 (21.42 g and 18.13 g for JG-11 and Annegiri, respectively) and I_1 (19.04 g and 17.23 g for JG-11 and Annegiri, respectively) treatments, respectively. The treatment I_4 and I_3 were on par with each other and were significantly superior to I_1 treatment which recorded the lowest test weight. The increase in test weight with the increase in irrigation frequency might be due to better growth of the crop, efficient dry matter partitioning and better translocation to the sink, leading to the formation of large sized seeds. In the case of highest irrigation level *i.e.* I_4 treatment, the decrease might be due to too frequent irrigation leading to poor grain filling when compared with I_3. These results were in conformation with those of Patel *et al.,* (1988), Singh and Dixit (1992), Chandrasekhar and Saraf (2005). The variety JG-11 has recorded highest test weight (24 g) when compared with Annegiri (20.83 g). Similar results were recorded by of Rao *et al.,* (2012). But the interaction effect of varied moisture regime and varieties was non-significant (Naik *et al.,* 2012).

Grain yield

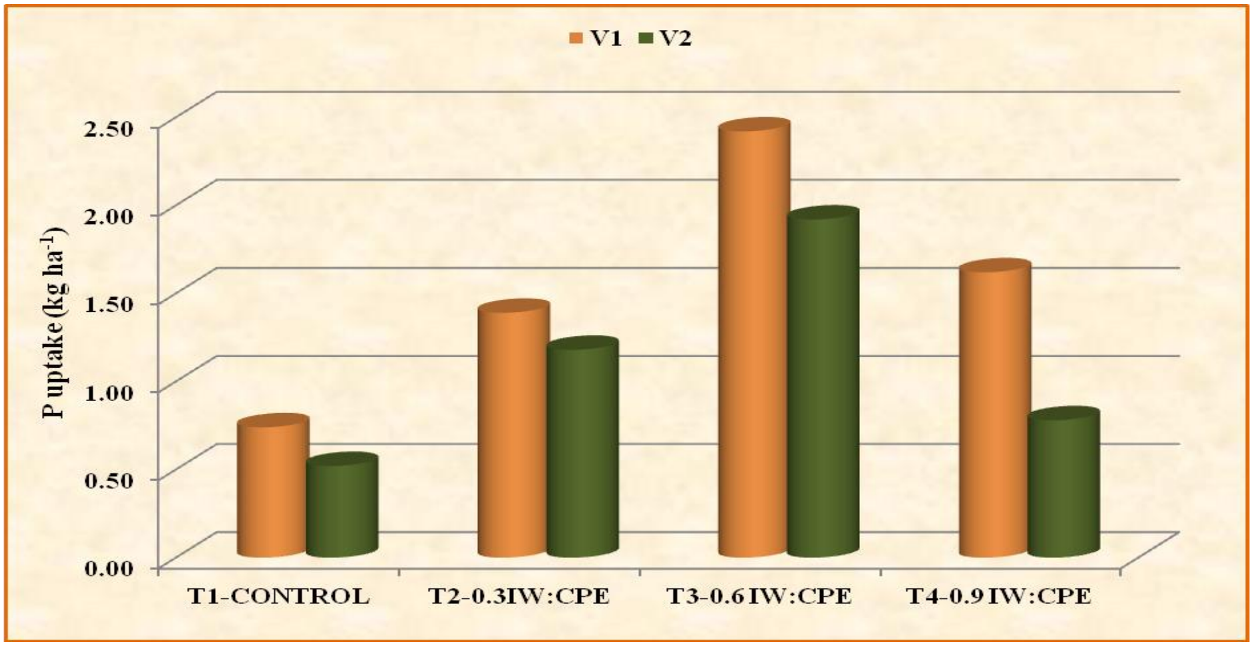
The highest grain yield was obtained when irrigation was scheduled at an IW: CPE ratio of 0.6 (I_3) (1882 kg ha^{-1} and 1655 kg ha^{-1} for JG-11 and Annegiri, respectively), but it was on par with I_4 (IW: CPE-0.9) (1722 kg ha^{-1} and 1542 kg ha^{-1} for JG-11 and Annegiri, repectively) treatment and I_4 is on par with I_2 (1567 kg ha^{-1} and 1322 kg ha^{-1} for JG-11 and Annegiri, respectively). The higher grain yield with more frequent irrigation might be accounted for their favorable influence on the growth characters (plant height and number of branches respectively) and yield attributing characters (no. of pods plant^{-1} and test weight, respectively). In case of I_4 treatment which provide maximum frequency of irrigation (four irrigations), the decrease in grain yield as compared to I_3 treatment might be due to frequent irrigations leading to relatively lesser seed filling as it was evident from the data on test weight. Similar findings were reported by Palled *et al.,* (1985), Chandrasekhar and Saraf (2005). With an increment in the no. of pods plant^{-1} and test weight, the grain yield was significantly increased. The JG-11 variety recorded significantly higher grain yield (1882 kg ha^{-1} at 0.6 IW: CPE ratio) as compared to Annegiri (1655 kg ha^{-1} at 0.6 IW: CPE ratio). These results were in conformity with Naik *et al.,* (2012), Rao *et al.,* (2012). Interaction effect between irrigation levels and varieties was non-significant with regard to the grain yield.

N Uptake of chickpea grain influenced by varied moisture regime



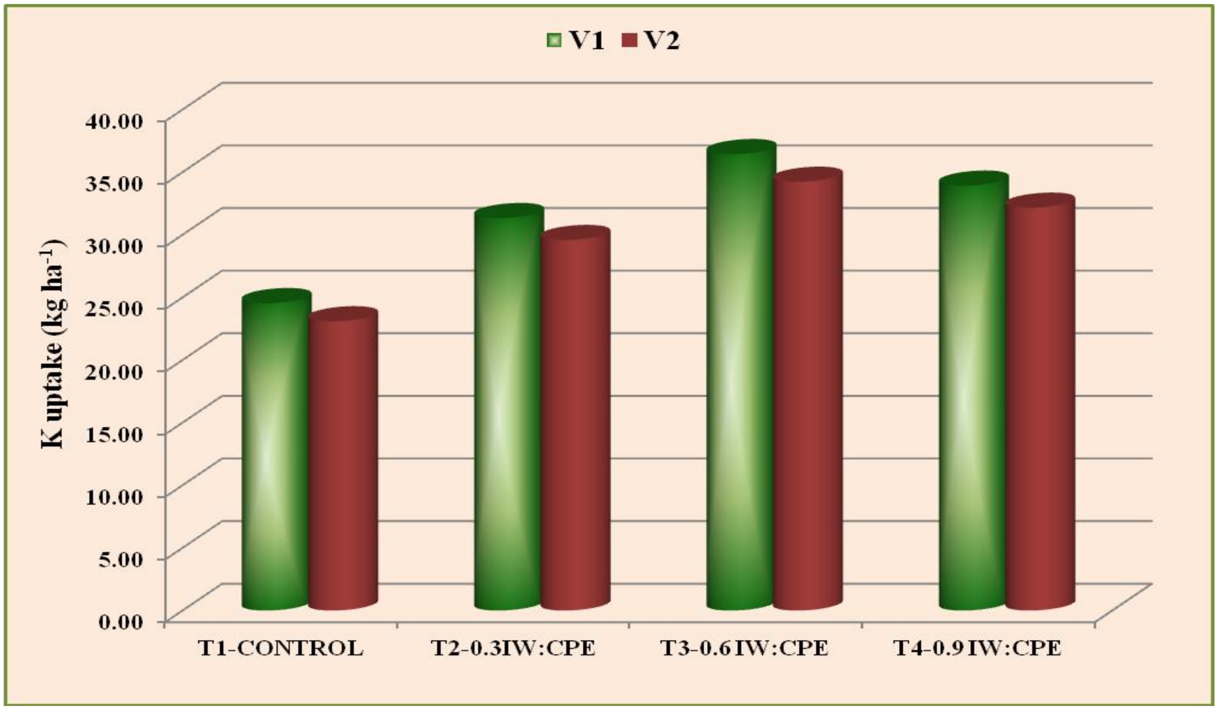
IW: CPE- Irrigation Water: Cumulative Pan Evaporation, V1- JG-11, V2-Annegiri

P Uptake of chickpea grain influenced by varied moisture regime



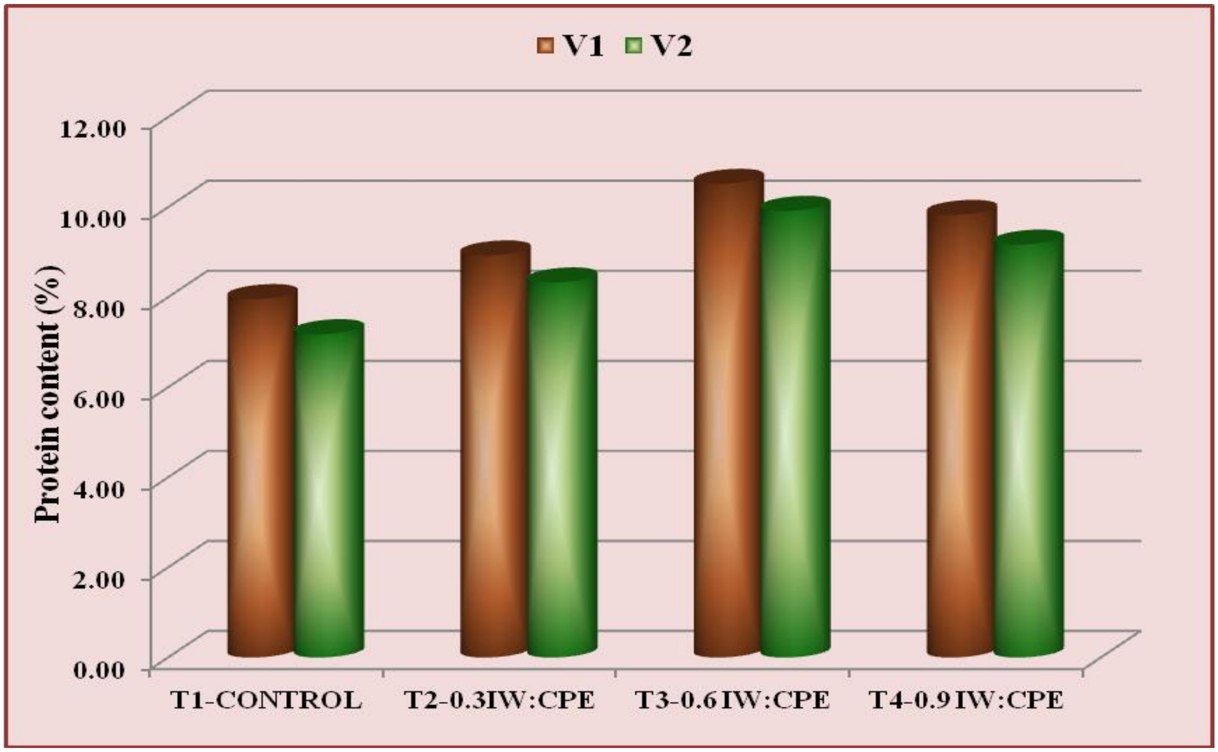
IW: CPE- Irrigation Water: Cumulative Pan Evaporation, V1- JG-11, V2-Annegiri

K Uptake of chickpea grain influenced by varied moisture regime



IW: CPE- Irrigation Water: Cumulative Pan Evaporation, V1- JG-11, V2-Annegiri

Quality parameter of chickpea grain influenced by varied moisture regime



IW: CPE- Irrigation Water: Cumulative Pan Evaporation, V1- JG-11, V2-Annegiri

Table.1 Yield attributes of chickpea varieties influenced by varied moisture regime

TREATMENTS	No. of pods plant^{-1}			No. of seeds pod^{-1}			Test weight (g)		
	V1	V2	Mean	V1	V2	Mean	V1	V2	Mean
T1-CONTROL	53.20	46.25	49.73	1.00	1.07	1.03	19.04	17.23	18.14
T2-0.3IW: CPE	62.07	54.13	58.10	1.00	1.00	1.00	21.42	18.13	19.78
T3-0.6 IW: CPE	74.27	65.30	69.78	1.00	1.07	1.03	24.00	20.83	22.42
T4-0.9 IW: CPE	70.17	61.52	65.85	1.13	1.00	1.07	23.84	20.2	22.02
Mean	63.18	55.23	59.20	1.03	1.03	1.03	22.08	19.10	20.59
	SE(m)	CD		SE(m)	CD		SE(m)	CD	
Factor A	1.64	4.97		0.02	NS		0.55	1.68	
Factor B	2.32	7.03		0.03	NS		0.78	2.37	
Factor (A x B)	3.28	NS		0.04	NS		1.11	NS	

IW: CPE- Irrigation Water: Cumulative Pan Evaporation
V1- JG-11, V2-Annegiri, Factor A-Varieties, Factor B- Irrigation levels

Table.2 Yield of chickpea varieties influenced by varied moisture regime

TREATMENTS	Grain yield (kg ha^{-1})			Haulm yield (kg ha^{-1})			Harvest index (%)		
	V1	V2	Mean	V1	V2	Mean	V1	V2	Mean
T1-CONTROL	1245	1008	1127	618	451	535	65.02	68.62	66.82
T2-0.3IW: CPE	1567	1323	1445	750	583	667	64.33	70.73	67.53
T3-0.6 IW: CPE	1882	1655	1769	893	794	844	65.93	65.97	65.95
T4-0.9 IW: CPE	1722	1542	1632	822	657	740	65.77	67.09	66.43
Mean	1604	1382	1493	771	621	696	65.26	68.10	66.68
	SE(m)	CD		SE(m)	CD		SE(m)	CD	
Factor A	72.05	218.55		29.93	90.81		1.51	NS	
Factor B	101.90	309.07		42.33	128.42		2.13	NS	
Factor (A x B)	144.10	NS		59.87	NS		3.01	NS	

IW: CPE- Irrigation Water: Cumulative Pan Evaporation+
V1- JG-11, V2-Annegiri, Factor A-Varieties, Factor B- Irrigation levels

Table.3 NPK uptake and protein content of chickpea grain influenced by varied moisture regime

TREATMENTS	N uptake (kg ha^{-1})			P uptake (kg ha^{-1})			K uptake (kg ha^{-1})			Protein content (%)		
	V1	V2	Mean	V1	V2	Mean	V1	V2	Mean	V1	V2	Mean
T1-CONTROL	51.06	54.45	52.76	0.32	0.22	0.27	24.54	23.09	23.82	19.13	18.67	18.90
T2-0.3IW: CPE	66.78	58.45	62.62	0.45	0.42	0.37	31.33	29.58	30.46	22.50	22.00	23.30
T3-0.6 IW: CPE	74.92	71.23	73.08	0.51	0.55	0.53	36.44	34.23	35.34	24.90	24.70	24.80
T4-0.9 IW: CPE	70.47	62.34	66.41	0.25	0.35	0.30	33.92	32.16	33.04	23.00	22.90	22.30
Mean	65.81	61.62	63.71	0.38	0.39	0.38	31.56	29.77	30.66	22.82	22.50	22.66
	SE(m)	CD		SE(m)	CD		SE(m)	CD		SE(m)	CD	
Factor A	1.11	3.36		0.04	NS		0.46	1.39		0.63	NS	
Factor B	1.57	4.76		0.06	NS		0.65	1.97		0.89	2.61	
Factor (A x B)	2.22	6.73		0.08	NS		0.92	2.79		1.25	NS	

IW: CPE- Irrigation Water: Cumulative Pan Evaporation,V1- JG-11, V2-Annegiri, Factor A-Varieties, Factor B- Irrigation levels

Haulm yield

Irrigation level I_3 recorded the maximum haulm yield (893 kg ha^{-1} and 794 kg ha^{-1} for JG-11 and Annegiri, repectively), but was on par with I_4 treatment (822 kg ha^{-1} and 657 kg ha^{-1} for JG-11 and Annegiri, repectively). The increase in haulm yield with increased in irrigation frequency of irrigation might be accounted for high vegetative growth and dry matter production. Similar findings were reported by Dabhi *et al.,* (1998) and Singh *et al.,* (2005). The varieties significantly differ among themselves higher haulm yield was obtained with JG-11 variety (893 kg ha^{-1}) when compared with Annegiri (794 kg ha^{-1}). Similar findings were reported by Rao *et al.*, (2012). Interaction effect of irrigation schedules and varieties has shown inconsistence which resulted in non-significant.

Form for going discussion, it can be concluded that, Irrigation scheduled at 0.6 IW: CPE (I_3) produced significantly higher yield attributes and grain and haulm yields of chickpea but it was on par with 0.9 IW: CPE (I_4). The JG-11 variety has produced higher grain yield than Annegiri.

NPK uptake (at harvest)

Varied moisture regime had a significant influence on N, P_2O_5 and K_2O uptake of plants at harvest (table 3).

Increasing irrigation frequency resulted in increase in total uptake of N, P_2O_5 and K_2O (table 3). The highest uptake was obtained with I_3 treatment. With additional increase in the frequency of irrigation upto I_4, nitrogen uptake was lower due to leaching losses and lower yield levels. The lowest uptake was obtained with I_1 (control) treatment. But as a whole, the increase in irrigation frequency resulted in higher solubility of nutrients and higher uptake. Meager water supply or excessive irrigation can result in unavailability or leaching of a major part of nutrients resulting in insufficiency of nutrient and low yields. Proper water management will hold these losses to a bare minimum. Likewise, the amount and movement of water in soil influence the availability of nutrients to plant roots. Similar findings were reported by Roy and Tripathi (1985), Dixit *et al.,* (1993), Srivastava and Srivastava (1994), Reddy and Ahlawat (1998).

The highest K uptake was obtained with I_3 treatment. With additional increase in the frequency of irrigation upto I_4, P uptake has been not influenced by irrigation.

Varieties and interaction effect of varied moisture regime and varieties has shown significant effect. Among varieties, JG-11 has showed more N and K uptake but P uptake remained non-significant.

Quality Parameter

Protein content (%)

It was evident from the data in (table 3) that the protein content of chickpea was significantly influenced by varied moisture regime. The treatment I_3 (0.6 IW: CPE) recorded (24.9% and 24.7% for JG-11 and Annegiri, respectively) significantly higher protein content as compared to I_1 - control (19.13 % and 18.67 % for JG-11 and Annegiri, respectively), I_2 -0.3 IW: CPE (22.50 % and 22 % for JG-11 and Annegiri, respectively) and I_4 -0.9 IW: CPE (23% and 22.9% for JG-11 and Annegiri, respectively). The lowest protein content was observed in I_1 (control) treatment. This finding is conformity with those of Dixit *et al.,* (1993).

The varieties as well as the interaction effect of irrigation schedules and varieties has no consistency and finally results in insignificant data.

In view of the experimental results obtained during the present investigation, Irrigation scheduled at 0.6 IW: CPE (I_3) produced significantly higher yield attributes and grain and haulm yields of chickpea but it was on par with 0.9 IW: CPE (I_4). The JG-11 variety has produced higher grain yield than Annegiri. The total N, P_2O_5 and K_2O uptake was lowest with I_1 (rainfed) and increasing frequency of irrigation resulted in higher uptake of nutrient. The treatment 0.6 IW: CPE (I_3) has recorded highest uptake. Genotype variation was not seen. Protein content (%) was highest in 0.9 IW: CPE (I_4) but it was on par with 0.6 IW: CPE (I_3). Treatment I_4 is significantly superior to I_1 (rainfed) and I_2 (0.3 IW: CPE). The varieties have no influence on protein content.

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