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Effect of irrigation levels on crop equivalent yield, water productivity and nutrient use efficiency of pulses in Dry Zone

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ABSTRACT

A field experiment was conducted on a sandy loam soil at college of Agriculture V. C. Farm Mandya, UAS Bengaluru in kharif 2016 to study the effect of irrigation levels on productivity of pulses in southern dry zone of Karnataka for achieving optimum irrigation schedule, higher yield and water productivity. The experiment was laid out in Split-plot Design with four levels of irrigation as main plot viz., irrigation at 60, 80, 100 per cent CPE (cumulative pan evaporation) and irrigation as per recommended irrigation practices in Southern Dry Zone of Karnataka. The pulses grown in Sub-plots were Greengram, Blackgram and Fieldbean. Analysis was done for crop equivalent yield. The results revealed that, significantly higher greengram equivalent yield was with irrigation at 80% CPE (1710 kg ha^{-1}) as compared to irrigation at 60% CPE and recommended practice (1427 and 1502 kg ha^{-1}, respectively) but was on par with irrigation at 100% CPE (1619 kg ha^{-1}). The water productivity was significantly higher with irrigation at 80% CPE (0.44 kg m^{-3}) as compared to rest of the irrigation levels (0.29, 0.39 and 0.39 kg m^{-3}). The nutrient use efficiency viz., N, P and K were significantly higher with irrigation at 80% CPE (43.25, 13.26 and 18.93 kg kg^{-1}, respectively) as compared to irrigation at 60% CPE and recommended practice, but was on par with irrigation at 100% CPE (37.08, 9.91 and 15.18 kg kg^{-1}, respectively). The treatment combination of irrigation at 80 per cent CPE and blackgram recorded significantly higher greengram equivalent yield of 2201 kg ha^{-1}, water productivity (0.62 kg m^{-3}) and NPK use efficiency(54.88, 16.76 and 24.40 kg kg^{-1}, respectively) ascompared to rest of the combinations. Hence scheduling irrigation at 80 per cent CPE in pulses enhances yield and water productivity in Dry Zone.
***Keyword**: Irrigation, Pulses, Equivalent yield, NUE, CPE.*

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INTRODUCTION

Pulses occupy a very significant place in Indian farming as they are the source of food, fodder and feed. They have ability to fix atmospheric nitrogen and play a very important role in sustaining soil productivity. Pulses are grown all over India and protein requirement of human being for growth and development is mostly met through pulses. Protein content in pulses ranges from 21-26 per cent, carbohydrates around 60 per cent and also a good source of vitamins like thiamin, riboflavin, niacin and ascorbic acid.

More than 85 per cent area under pulses depends on rainfall, while water is life of any crop [9]. The area and production growth of pulses is slow due to low productivity of 411 kg ha^{-1} during 1950-51 and 688 kg ha^{-1} during 2010-11 over six decades; however the area under pulses 19.03 million ha during 1950-51 increased to 26.68 million ha only, as compared to food grain production [9].

In view of rapid increase in population and day by day decrease in water resources and to fulfill the increasing pulse demand and decreasing pulse production; sustainable water management practices and estimation of water requirement will help to increase productivity of pulses, water productivity, water use efficiency and area of pulses under irrigation. Improving water use efficiency in agriculture will require an increase in crop water productivity i.e., an increase in marketable crop yield per unit of water used by plant and reduction in water losses from the crop root zone. Among the sustainable water management practices, scheduling irrigation based on evaporation is one of the best methods in semi arid condition where annual rainfall is low.

Crop water requirement is the total water needed for evapotranspiration, from planting to harvest for a given crop in a specific climate regime, when adequate soil moisture maintained by rainfall and/or irrigation so that it does not limit plant growth and crop yield [4]. The assessment of water needs of the crop based on day to day weather parameters seems to be more rational than any other method [13]. In agricultural fields, large spatial variations in soil water content are associated with soil heterogeneities such as precipitation level, land cover, topography, evapotranspiration etc. Scientific irrigation scheduling should go with an understanding of soil-water-plant-atmosphere continuum. Irrigation water economy can be aimed through appropriate irrigation schedules and meteorological approach based on pan evaporation is one of the simplest, reliable, economical and least time consuming methods [10]. Keeping this in view, the present investigation "Growth and yield of pulses as influenced by irrigation levels in Southern Dry Zone of Karnataka" was taken up during *kharif* 2016 at college of Agriculture, Vishweshwaraiah Canal Farm, Mandya.

MATERIAL AND METHODS

A field experiment was conducted during *kharif* season of 2016 at Collage of Agriculture, Vishweshwaraiah Canal Farm, Mandya (Karnataka) to study the performance of pulses with irrigation levels in southern dry zone of Karnataka. The experiment was laid out in split plot design with four irrigation levels *viz.,* irrigation at 60 % (I_1), 80 % (I_2), 100 % (I_3) of cumulative pan evaporation (CPE) and recommended irrigation practice in southern dry zone of Karnataka (I_4) as main plot and three pulses *viz.,* P_1: greengram (KKM-3), P_2: blackgram (Rashmi) and P_3: fieldbean (HA-4) as sub plot with three replications. The soil of experimental site is red sandy loam with neutral soil pH (7.6), organic carbon content was medium (0.66 percent) with an electrical conductivity (EC) of 0.18 dSm^{-1},medium in available nitrogen (275.96 kg/ha), phosphorus (30.77 kg/ha) and potassium (201.26 kg/ ha). The pulses were planted on 16 July 2016 with common row spacing of 30 and 10 cm between plants. Equal quantity of farm yard manure at the rate of 5 t/ha was applied to each plot three weeks prior to planting. The recommended doses of 25 kg of nitrogen, 50 kg P_2O_5 and 25 kg K_2O per ha were applied uniformly as basal dose at the time of planting in the form of urea, single super phosphate and muriate of potash, respectively. One general irrigation at 5 cm depth was given to all plots after sowing to ensure uniform germination and crop establishment and counted the applied water through water meter. The required quantity of water per plot based on 60%, 80% and 100% cumulative pan evaporation was calculated by using USWB open pan evaporimeter. For recommendedirrigation practice water was applied @ 5 cm depth. For measuring the water to be applied for each treatments water meter was used. Measured quantity of water (liter $plot^{-1}$) was applied through surface irrigation at an interval of 8 days. Three irrigation levels *viz.,* 60, 80 and 100 per cent CPE were compared with recommended irrigation practice (5cm).The yield was converted to greengram equivalent yield of blackgram and fieldbean and statistically analysed using Fisher's method of analysis of variance technique as given by Panse and Sukhatme [6].

$$\text{CEY (greengram)} = G.G_y + B.G_y \times \frac{B.G_{pc}}{G.G_{pc}} + F.B_y \times \frac{F.B_{pc}}{G.G_{pc}}$$

G.G= greengram, B.G= blackgram, F.B= fieldbean, y= yield (kg ha^{-1}) and pc= price (Rs kg^{-1})

Analysis of nutrient use efficiency (NUE) and water productivity were done for greengram equivalent yield of blackgram and fieldbean.

$$\text{Water productivity} = \frac{\text{Seed yield (kg ha}^{-1})}{\text{Total water used (m}^{3})}$$

$$\text{NUE} = \frac{\text{Grain yield (kg ha}^{-1})}{\text{Fertilizer nutrient applied (kg ha}^{-1}) + \text{Soil nutrient (kg ha}^{-1})}$$

RESULTS AND DISCUSSION

Greengram Equivalent Yield

The data recorded on grain yield of greengram, blackgram and fieldbean (Table 1) as influenced by irrigation levels was converted in to greengram equivalent yield and presented in Table 2. Irrigation at 80 per cent CPE resulted in significantly higher greengram equivalent yield 1710 kg ha-1, and which was 13.84 per cent higher than the yields obtained with recommended irrigation practice (1502 kg ha^{-1}), but it was on par with Irrigation at 100 per cent CPE (1619 kg ha^{-1}). However, the lowest yield was recorded with irrigation at 60 per cent CPE (1427 kg ha^{-1}).

The treatment combinations of irrigation levels and pulses showed significant difference in greengram equivalent yield. Scheduling irrigation at 80 per cent CPE with blackgram recorded the highest greengram equivalent yield (I_2P_2: 2201 kg ha^{-1}) followed by (I_3P_2: 2084 kg ha^{-1}) as compared to all other combinations.

Irrigation scheduling at 0.8 IW/CPE ratio significantly increased the seed yield of chick pea (1156 kg ha^{-1}) respectively, as compared to irrigation schedules IW/CPE ratio 1.0, 0.6 and 0.4 (Patel*et al.,* 2009). These higher grain yield and yield parameters in irrigation level at 80 per cent CPE might be attributed to its key role in root development by mechanical resistance leads to greater nutrient uptake and higher transpiration resulted in more photosynthesis [15]. Another reason may be due to maintenance of optimum soil moisture condition which affected the root nodulation as well as availability of different nutrients, further adequate availability of moisture at all stages of crop growth and development lead to high water potential, stomatal conductance, higher photosynthesis, partioning of photosynthates to sink consequently increasing dry matter production and ultimately increased yield parameters and yield [2]. Scheduling irrigation at 0.8 IW/CPE ratiomaintained optimum soil moisture condition throughout the crop growth period as observed by Kapil *et al.,* [5].

Reason for low yield in 60 per cent CPE might be due to unsaturated soil moisture environment and vapour gap around the roots by their turgor pressure under water stress. Such a gap if ever present would reduce the availability of nutrients to the roots probably due to lesser contact between roots and water particle causing drastic reduction in dry matter production and uptake of nutrients [8] and in case of recommended practice (5 cm) it might be due to reduced oxygen concentration in wet soil due to wet condition which might have caused stomatal closure of plant which lead to stress because plant can't transpire at optimal rate although water is available [16].

Total Water Used

Total water used by different treatment is presented in Table 2. The lowest quantity of water was used by treatment 60 per cent CPE (3600 m^{3}ha^{-1}) which saved 37.05 per cent of water than recommended irrigation practice (5721 m^{3}ha^{-1}), 14.05 per cent than 100 per cent CPE (4191 m^{3}ha^{-1}) and 7.55 per cent than 80 per cent CPE (3900 m^{3}ha^{-1}), respectively. Irrigation levels at 80 percent CPE and 100 per cent CPE were saved 31.90 and 26.76 per cent water, respectively, over recommended irrigation level.

Total water used by all pulses (greengram, blackgram and fieldbean) were same (4353 m^{3}ha^{-1}).

Among treatment combinations, irrigation at 60 per cent CPE in all pulses (greengrm, blackgram and field bean), used lower amount of water (3600 m^{3}ha^{-1}) and recommended practice it was higher (5721 m^{3}ha^{-1}).

Water Productivity

Water productivity of pulses (greengram, blackgram and fieldbean) was calculated for greengram equivalent yield and presented in Table 2. The trend of water productivity was exactly reverse to that of trend observed in grain yield except, irrigation at 80 per cent CPE. Maximum water productivity was observed in treatments receiving less water except, irrigation at 80 per cent CPE. Scheduling irrigation at 80 per cent CPE resulted in significantly higher water productivity (0.44 kg m^{-3}) ascompared to other irrigation levels. Irrigation levels 60 per cent and 100 per cent CPE recorded significantly higher water productivity (0.39 and 0.39 kg m^{-3}, respectively) over farmer's practice (0.29 kg m^{-3}), but were at par with each other.

The treatment combinations of irrigation levels and pulses showed significant difference in water productivity. Treatment combination of blackgram with irrigation level at 80 per cent CPE recorded significantly higher water productivity (I_2P_2: 0.62 kg m^{-3}) followed by blackgram with 100 per cent CPE (I_3P_2: 0.55 kg m^{-3}) and blackgram with 60 per cent CPE (I_1P_2: 0.55 kg m^{-3}) than other combinations. However, the lowest water productivity recorded with recommended irrigation level with greengram combination (I_4P_1: 0.18 kg m^{-3}).

Water use efficiency of greengram was significantly higher in irrigation schedule IW/CPE 0.8 (49.41 kg ha-mm^{-1}) over 0.6 and 1.0 IW/CPE (49.12 and 39.24 kg ha-mm^{-1}, respectively), which were significantly better than irrigation at 10 days interval (38.99 kg ha-mm^{-1}) [12]. These results might be due to the fact that under increased quantity of water applied resulted in high moisture regimes and more moisture is used for evaporation than production as the availability of water was more than the crop irrigated with less water [12].

Nutrient Use Efficiency

Nutrient use efficiency*viz.,* N, P and Kof pulses (greengram, blackgram and fieldbean) was calculated for greengram equivalent yield and presented in Table 3. Scheduling irrigation at 80 per cent CPE resulted in significantly higher nutrient use efficiency (43.25, 13.26 and 18.93 N, P and K kg kg^{-1},respectively) ascompared to recommended irrigation practice and irrigation at 60 per cent CPE. However, it was on par with irrigation at 100 per cent CPE (39.86, 11.39 and 17.62 N, P and K kg kg^{-1}, respectively).

The treatment combinations of irrigation levels and pulses showed significant difference in nutrient use efficiency of pulses. Scheduling irrigation at 80 per cent CPE with blackgram recorded the highest nutrient use efficiency (I_2P_2: 54.88, 16.76 and 24.40 N, P and K kg kg^{-1}, respectively) followed by (I_3P_2: 51.18, 14.59 and 22.47 N, P and K kg kg^{-1}, respectively) as compared to all other combinations. These results might be due to maintenance of optimum moisture condition in soil which played an important role in nutrient uptake involving diffusion, mass flow and root interception. Adequate soil moisture condition helps to better root penetration and proliferation leading to higher nutrient uptake [3]. Soil with optimum water contents helps better solubility of nutrient than limited water status as well as reduces the chance of leaching of major part of nutrient due to excess water leads to higher uptake [11]. As increase the uptake of nutrient leads to increased nutrient use efficiency.

Similar results are also obtained by Ravi Nandan and Prasad [11], Singh *et al.* [14], Behura and Mohapatra [1] and Dutta *et al.* [3].

Table 1: Grain yield (kg ha^{-1}) of greengram, blackgram and fieldbean is influenced by irrigation levels

TREATMENTS	Greengram	Blackgram	Fieldbean
I_1	770	1036	1176
I_2	956	1222	1332
I_3	900	1161	1272
I_4	824	1066	1222

I_1: Irrigation at 60% CPE
I_2: Irrigation at 80% CPE
I_3: Irrigation at 100% CPE
I_4: Irrigation as per recommended practice in southern dry zone of Karnataka

Table 2: Greengram equivalent yield (Kg ha^{-1}) of blackgram and fieldbean and water productivity (Kg m^{-3}) as influenced by irrigation levels

	Greengram equivalent yield (Kg ha^{-1})				Total water used (m^3 ha^{-1})				WUE (Kg m^{-3})			
	P_1	P_2	P_3	Mean	P_1	P_2	P_3	Mean	P_1	P_2	P_3	Mean
I_1	770	1826	1685	**1427**	3600	3600	3600	**3600**	0.23	0.55	0.40	**0.39**
I_2	956	2201	1974	**1710**	3900	3900	3900	**3900**	0.27	0.62	0.44	**0.44**
I_3	900	2084	1872	**1619**	4191	4191	4191	**4191**	0.24	0.55	0.39	**0.39**
I_4	824	1907	1775	**1502**	5721	5721	5721	**5721**	0.18	0.41	0.28	**0.29**
Mean	**863**	**2004**	**1826**		**4353**	**4353**	**4353**		**22.85**	**53.10**	**37.36**	
	S.Em±		**CD @ 5%**						**S.Em±**		**CD @ 5%**	
Irrigation Levels	**52.44**		**180.42**						**0.01**		**0.04**	
Interaction	**13.71**		**40.97**						**0.009**		**0.01**	

I_1: Irrigation at 60% CPE
I_2: Irrigation at 80% CPE
I_3: Irrigation at 100% CPE
I_4: Irrigation as per recommended practice in southern dry zone of Karnataka
P_1: Greengram, P_2: Blackgram, P_3: Fieldbean

Table 3: Nutrient use efficiency (kg kg^{-1}) for greengram equivalent yield of blackgram and fieldbean as influenced by irrigation levels

	Nutrient use efficiency (kg kg^{-1})											
	N				**P**				**K**			
	P_1	P_2	P_3	Mean	P_1	P_2	P_3	Mean	P_1	P_2	P_3	Mean
I_1	18.97	43.03	40.73	**34.24**	4.54	12.47	11.30	**9.44**	7.54	19.44	17.68	**14.88**
I_2	24.57	54.88	50.30	**43.25**	7.75	16.76	15.29	**13.26**	10.64	24.40	21.74	**18.93**
I_3	21.08	51.18	47.32	**39.86**	6.17	14.59	13.40	**11.39**	10.37	22.47	20.03	**17.62**
I_4	20.25	46.41	44.57	**37.08**	5.20	12.62	11.92	**9.91**	8.17	19.24	18.14	**15.18**
Mean	**21.22**	**48.88**	**45.73**		**5.91**	**14.11**	**12.98**		**9.18**	**21.39**	**19.40**	
	S.Em±		**CD @ 5%**		**S.Em±**		**CD @ 5%**		**S.Em±**		**CD @ 5%**	
Irrigation Levels	**1.75**		**6.03**		**0.94**		**3.24**		**0.98**		**3.37**	
Interaction	**1.00**		**3.00**		**0.38**		**1.13**		**0.37**		**1.11**	

I_1: Irrigation at 60% CPE
I_2: Irrigation at 80% CPE
I_3: Irrigation at 100% CPE
I_4: Irrigation as per recommended practice in southern dry zone of Karnataka
P_1: Greengram, P_2: Blackgram, P_3: Fieldbean

REFERENCES

1. Behura, A. K. And Mahapatra, P. K., (2007), Effect of irrigation and nitrogen on grain yield response, nutrient uptake rates, nitrogen harvest index (%), crude protein (%) and partial factor productivity of nitrogen in rajmash (*Phaseolus vulgaris* L.). *Leg. Res.,* **30**(4): 266-270.

2. Chaudhary, A. N., Vihol, K. J. And Mor, V. B., (2014), Water use efficiency, yield, available nutrient and economics of greengram (*Vigna radiate* (L.) Wilczek) as influenced by plant density and irrigation management. *Trends in Bioscies,* **7**(22): 3761-3764.

3. Dutta, D., Dutta, D. M., Murmu, P. And Thentu, T. L., (2015), Response of groundnut (*Arachishypogaea*) to irrigation schedules, sulphur levels and sources in alluvial zone of West Bengal.*Indian J. Agron.,* **60**(3): 443-449.

4. Hess, T., 2005, Crop water requirements.*Water and Agriculture, WCA info NET.*

5. Kapil S., Sandal, S. K. And Rana, K., (2015), Effect of irrigation scheduling and NK fertigation on productivity of garden peas (*Pisumsativum*var. *hortense*L.). *Himachal J. Agril. Res.,* **41**(2): 126-131.

6. Panse, V. G. And Sukhatme, P. V., (1967), Statistical methods for agricultural workers. ICAR, Publ., New Delhi, p.359.

7. Patel, A. P., Patel, D. B., Lakhani S. H. And Kadu S. P., (2014), Influence of irrigation scheduling and levels of sulphur on yield and quality of rabigreengram [*Vigna radiate* (L.) Mills].*Trends in Biosci.,***7**(21): 3485-3489.

8. Patel, K. B., Tandel, Y. N. And Arvadia, M. K., (2009), Effect of irrigation and land configuration on growth, yield and quality of chickpea [*Cierarietinum*(L.)] under vertisol of South Gujarat. *Int. J. Agril. Scis.*,**5**(1): 295-296.

9. Prem Narayan And Sandeep Kumar., 2015, Constraints of growth in area production and productivity of pulses in India: An analytical approach to major pulses. *Ind. J. Agric. Res*., **49**(2): 114-124.

10. Prihar, S.S., Khera, K.L., Sandhu, K. S. And Sandhu, B. S., (1976), Mulch, nitrogen and irrigation effects on growth, yield and nutrient uptake of forage corn. *Agron. J*., **68:** 937-941.

11. Ravi Nandan And Prasad, U. K., (1998), Effect of irrigation and nitrogen on growth, yield, nitrogen uptake and water-use efficiency of frenchbean*(Phaseolus vulgaris).Indian J. Agril. Sci.,* **67**(11): 75-80.

12. Sanjay Yadav And Singh, B. N., (2014), Effect of irrigation schedules and planting methods on growth, productivity and WUE of greengram (*Phaseolus radiate* L.) under rice-wheat-greengram cropping system. *Pl. Archi.,***14**(1): 211-213.

13. Senthilkumar, P., (1990), M.Sc. (Ag.), Thesis, Tamil Nadu Agricultural University, Coimbatore.

14. Singh, G., Kumar, S., Data, R., Singh, T. P. And Singh, T., (2003), Response of frenchbean*(Phaseolus vulgaris* L.) to fertility levels and moisture regimes.*Veg. Sci.,* **30**(1):87-88.

15. Solanki, R. M., Sagarka, B. K., Dabhi, B. M., Shaikh, M. A. And Gohil, B. S., (2012), Response of chickpea to drip irrigation and integrated nutrient management under Saurashtra region of Gujarat.*Agriculture: Towards a New Paradigm of Sustainability ISBN*: 978-93-83083-64-*0*.

16. Suat, I. And William, R. R., (2008), Plant growth and yield as affected by wet soil conditions due to flooding or over-irrigation. *Neb Guide, University of Nebraska-Lincoln Extension.*

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