

Effect of Irrigation Levels and Hydrogel Application on Growth, Yield and Quality of Chickpea Varieties

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Abstract Field experiment was conducted during 2014 *rabi* season at Water Management Research Center (IWMRC) Belavathi, UAS, Dharwad to know the effect of irrigation levels and hydrogel application on growth, yield and quality of chickpea varieties under irrigated condition. Irrigation scheduled at 0.6 IW/CPE + 2.5 kg ha⁻¹ hydrogel recorded significantly higher grain yield (1920 kg ha⁻¹) as compared to irrigation scheduled at 0.4 IW/CPE (1648 kg ha⁻¹).

Among the varieties A-1 recorded significantly higher grain (1894 kg ha⁻¹) was on par with ICCV-2 (1938 kg ha⁻¹), JG-11 (1865) and JAKI-9218 (1766 kg ha⁻¹). Interaction effect of irrigation levels and varieties was significant. A-1 variety with 0.6 IW/CPE + 2.5 kg ha⁻¹ hydrogel (I₄V₁) recorded significantly higher grain yield (2152 kg ha⁻¹) as compared to other treatment combinations.

Keywords Irrigation schedule, IW/CPE ratio, Hydrogel, Chickpea varieties.

Introduction

Pulses are an integral component of Indian agriculture and they are an important source of dietary proteins for the people, more so for a large vegetarian population of India. Chickpea (*Cicer arietinum* L.) is an important pulse crop of *rabi* season cultivated mainly in semi-arid and warm temperature regions of the world. It contains 18 to 24% protein which is almost three times more than that of cereals. India is one of the important chickpea growing countries in Asia with an area 8.7 million hectares and production of 8.83 million tonnes with a productivity of 1014 kg ha⁻¹ [1]. Karnataka is one of the major chickpea producing states in the country and is being grown over an area of 8.03 lakh hectares with an annual production of 3.95 lakh tonnes, having an average productivity of 518 kg ha⁻¹ [1]. SAP hydrogel is potentially influence soil permeability, density, structure, texture,

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Table 1. Yield and yield attributing characters of at harvesting stage as influenced by irrigation schedules with hydrogel application and chickpea varieties. I₁ - 0.4 IW/CPE, I₂ - 0.4 IW/CPE + 2.5 kg/ha hydrogel, I₃ - 0.6 IW/CPE, I₄ - 0.6 IW/CPE + 2.5 kg ha hydrogel, V₁ - Annigeri-1, V₂ - JG-11, V₃-BGD-103, V₄-JAKI-9218, V₅-ICCV-2. Means followed by the same letter (s) within a column are not significantly differed by DMRT ($p=0.05$).

Treat- ments	Grain yield (kg ha ⁻¹)					Haulm yield (kg ha ⁻¹)					Hundred seed weight (g)				
	Irrigation levels					Irrigation levels					Irrigation level				
	I ₁	I ₂	I ₃	I ₄	Mean	I ₁	I ₂	I ₃	I ₄	Mean	I ₁	I ₂	I ₃	I ₄	Mean
Varieties															
V ₁	1698 ^{c-f}	1839 ^{b-e}	1888 ^{a-e}	2152 ^a	1894 ^a	1800 ^{c-e}	1906 ^{a-d}	2058 ^{ab}	2086 ^a	1963 ^a	4854 ^a	4912 ^a	4783 ^a	5078 ^a	4907 ^a
V ₂	1786 ^{c-f}	1870 ^{b-e}	1981 ^{a-c}	1822 ^{b-e}	1865 ^a	1869 ^{b-e}	1970 ^{a-c}	2073 ^a	1922 ^{c-d}	1959 ^a	4886 ^a	4831 ^a	4881 ^a	4867 ^a	4866 ^a
V ₃	1529 ^f	1624 ^{ef}	1674 ^{d-f}	1626 ^{ef}	1613 ^b	1780 ^{c-e}	1801 ^{c-e}	1874 ^{b-e}	1789 ^{c-e}	1811 ^c	4618 ^a	4740 ^a	4707 ^a	4761 ^a	4706 ^a
V ₄	1610 ^{ef}	1722 ^{cf}	1804 ^{b-f}	1928 ^{a-d}	1766 ^a	1692 ^e	1795 ^{c-e}	1888 ^{a-e}	2057 ^{ab}	1858 ^{bc}	4874 ^a	4886 ^a	4885 ^a	4837 ^a	4871 ^a
V ₅	1619 ^{ef}	1834 ^{b-e}	1986 ^{a-c}	2075 ^{ab}	1878 ^a	1738 ^{de}	1908 ^{a-d}	2038 ^{ab}	2067 ^{ab}	1938 ^{ab}	4829 ^a	4884 ^a	4946 ^a	5011 ^a	4917 ^a
Mean	1648 ^b	1778 ^{ab}	1867 ^a	1920 ^a		1776 ^b	1876 ^{ab}	1986 ^a	1984 ^a		4812 ^a	4851 ^a	4840 ^a	4911 ^a	
SV	SEm±					SEm±					SEm±				
Irrigation	39.70					34.55					0.11				
Varieties	42.53					29.36					0.28				
I × V	85.06					58.72					0.56				

evaporation and infiltration rates of water through the soils. Particularly, the hydrogel reduce irrigation frequency and compaction tendency, stop erosion, water runoff and increase the soil aeration and microbial activity

Materials and Methods

The research was conducted at IWMRC, Belavatgi, Dharwad district during *rabi* season of 2014. The composite soil sample of experimental area was collected before sowing and analyzed for important physical and chemical properties. The experimental site was low in nitrogen (157 kg ha⁻¹), medium in phosphorus (36.6 kg ha⁻¹) and high in potash (780 kg ha⁻¹). Experiment was laid out in split plot design replicated four irrigation with and without hydrogel levels and chickpea varieties. The net plot size was 3.6 m × 1.8 m (6.48 m²). The effect of irrigation levels with and without hydrogel and performance of early maturing *kabuli* variety (ICCV-2) and comparison with *desi* varieties (A-1, JG-11, BGD-103, JAKI-9218) were made. For statistical analysis data were analyzed using analysis of variance and means were compared using (CD) at the 5% probability and DMRT.

Results and Discussion

Effect of irrigation level with application of hydrogel on growth and yield components of chickpea

The grain and haulm yield of chickpea were significantly influenced by irrigation levels. Irrigation scheduled at 0.6 IW/CPE + 2.5 kg ha⁻¹ hydrogel (I₄) recorded significantly higher grain and haulm yield (1920 and 1986 kg ha⁻¹, respectively) which were on par with irrigation scheduled at 0.6 IW/CPE (I₃-1867 and 1984 kg ha⁻¹, respectively) and 0.4 IW/CPE + 2.5 kg ha⁻¹ hydrogel (I₂-1778 and 1876 kg ha⁻¹, respectively). Irrigation levels and hydrogel application did not significantly influence the harvest index of chickpea varieties (Table 1). However irrigation scheduled at 0.6 IW/CPE + 2.5 kg ha⁻¹ hydrogel (I₄) recorded higher harvest index (49.1%) over rest of the treatments. Chickpea responds well to irrigation levels especially under delayed sowing. Increase in the chickpea grain yield was from 1648 kg ha⁻¹ to 1920 kg ha⁻¹ due to irrigation. Scheduling irrigation at I₄ increased the grain yield by 14.25 over I₁ and this was significant over other irrigation. This treatment also recorded 2.7% and 7.5% higher yield over I₃ and I₂ respectively. Haulm yield of chickpea was significantly high in I₄ and similar yield was also noticed in I₃ and I₂. The extent of increase in haulm yield of I₄ over I₂ was by 1.48%. The increase in the grain yield (14.2%) was

Table 2. Yield attributing characters of chickpea at harvesting stage as influenced by irrigation schedules with hydrogel application and chickpea varieties. I₁ - 0.4 IW/CPE, I₂ - 0.4 IW/CPE + 2.5 kg/ha hydrogel, I₃ - 0.6 IW/CPE, I₄ - 0.6 IW/CPE + 2.5 kg ha hydrogel, V₁ - Annigeri-1, V₂ - JG-11, V₃-BGD-103, V₄-JAKI-9218, V₅-ICCV-2. Means followed by the same letter (s) within a column are not significantly differed by DMRT ($p=0.05$).

Treat- ments	Pod plant ⁻¹ Irrigation levels					Seed weight (g plant ⁻¹) Irrigation levels					Hundred seed weight (g) Irrigation level				
	I ₁	I ₂	I ₃	I ₄	Mean	I ₁	I ₂	I ₃	I ₄	Mean	I ₁	I ₂	I ₃	I ₄	Mean
Varieties															
V ₁	44.20 ^l	60.03 ^b	60.43 ^b	68.00 ^a	58.17 ^a	11.17 ^{a-c}	11.56 ^{ab}	12.42 ^a	12.53 ^a	11.92 ^a	19.00 ^b	19.50 ^{gh}	19.83 ^{gh}	20.17 ^{f-h}	19.63 ^d
V ₂	44.67 ^l	51.60 ^{f-h}	52.70 ^{ef}	51.07 ^{fh}	50.01 ^c	10.97 ^{a-c}	12.23 ^a	12.67 ^a	11.27 ^{a-c}	11.78 ^a	19.67 ^{gh}	20.17 ^{f-h}	20.83 ^{gh}	21.67 ^{c-f}	20.58 ^c
V ₃	36.13 ^m	38.10 ^{lm}	41.10 ^k	39.87 ^{ki}	38.80 ^d	9.17 ^c	9.80 ^{bc}	9.83 ^{bc}	10.74 ^{a-c}	9.89 ^b	28.17 ^a	28.83 ^a	28.83 ^a	29.17 ^a	28.75 ^a
V ₄	49.20 ^b	49.70 ^{gh}	50.20 ^{gh}	54.43 ^{dc}	50.88 ^c	10.93 ^{a-c}	10.43 ^{ac}	11.17 ^{a-c}	12.20 ^a	11.18 ^a	19.83 ^{gh}	21.00 ^{d-g}	21.17 ^{d-g}	22.67 ^{b-d}	21.17 ^c
V ₅	46.90 ⁱ	52.00 ^{fg}	56.17 ^{cd}	57.73 ^c	53.21 ^b	10.85 ^{a-c}	11.19 ^{a-c}	12.17 ^a	12.37 ^a	11.64 ^a	22.00 ^{c-e}	22.33 ^{b-e}	23.00 ^{bc}	24.00 ^b	22.83 ^b
Mean	44.22 ^d	50.29 ^c	52.12 ^b	54.22 ^a		10.62 ^c	11.04 ^{bc}	11.65 ^{ab}	11.82 ^a		21.73 ^c	22.37 ^b	22.73 ^b	23.53 ^a	
SV	SEm±					SEm±					SEm±				
Irrigation	0.38					0.19					0.11				
Varieties	0.38					0.34					0.28				
I × V	0.76					0.69					0.56				

higher than haulm yield (10.42%) in I₄ over I₁ and this signifies the importance of irrigation in pulse crop like chickpea. Similar increase in the yield of *kabuli* chickpea was noticed between 0.8 IW/CPE and no irrigation at Dharwad condition [2]. Significantly higher number of pods per plant, seed weight per plant and hundred seed weight (54.22, 11.82 g and 23.53 g, respectively) was noticed when the irrigation was scheduled at 0.6 IW/CPE + 2.5 kg ha⁻¹ hydrogel (I₄). The yield parameters were directly correlated with the growth parameters.

The variation in yield and yield attributes could be traced back to the improved growth parameters like, plant height, number of primary and secondary branches per plant, total dry matter production and number of nodules. Irrigation was applied two days after the 30th day in I₃ and I₄ treatments. In the present investigation significantly higher plant height, secondary branches per plant and total dry matter production (41.29 cm, 12.76, 34.97 g plant⁻¹ at harvest, respectively) was recorded with irrigation scheduled at 0.6 IW/CPE + 2.5 kg ha⁻¹ hydrogel (I₄) compared to irrigation scheduled at 0.4 IW/CPE (I₁). The increase in plant growth was probably due to one more irrigation applied in I₃ and I₄ compared to I₁ and I₂. Significantly higher dry matter in reproductive parts at harvest is attributed to significantly higher number of

Pods per plant in treatments receiving irrigation with 0.6 IW/CPE.

Effect of chickpea varieties on growth and yield components of chickpea

The grain and haulm yield of chickpea were significantly varied within varieties (Table 2). Among the varieties Annigeri-1 (V₁) recorded significantly higher grain and haulm yield (1894 and 1963 kg ha⁻¹) which were on par with ICCV-2 (V₅ = 1878 and 1938 g ha⁻¹, respectively) and JG-11 (V₂ = 1865 and 1969 kg ha⁻¹, respectively). Lower grain and haulm yield (1613 and 1811 kg ha⁻¹) were recorded by the BGD-103 (V₃). The harvest index of chickpea was not significantly influenced by the varieties. However the variety ICCV-2 (V₅) recorded higher harvest index (49.17%) over rest of the varieties. Similar better performance of Annigeri-1 was also reported by Nagarajaiah [3]. The number of pods per plant and seed weight per plant of chickpea was significantly influenced by varieties. Among the varieties Annigeri-1 recorded significantly higher number of pods per plant (V₁ = 58.17 and 11.92 g, respectively) over rest of the treatments followed by variety ICCV-2 (V₅ = 53.21 and 11.64 g, respectively). Significantly lower number of pods per plant and seed weight per plant (38.8 and 9.89 g) was recorded by the variety BGD-103 (V₃). Among the varieties BGD-103

Table 3. Growth parameters of chickpea at harvesting stage as influenced by irrigation schedules with hydrogel application and chickpea varieties. I_1 - 0.4 IW/CPE, I_2 - 0.4 IW/CPE + 2.5 kg/ha hydrogel, I_3 - 0.6 IW/CPE, I_4 - 0.6 IW/CPE + 2.5 kg/ha hydrogel, V_1 - Annigeri-1, V_2 - JG-11, V_3 - BGD-103, V_4 - JAKI-9218, V_5 - ICCV-2. Means followed by the same letter (s) within a column are not significantly differed by DMRT ($p=0.05$).

Treatments	Plant height (cm)					Secondary branches plant ⁻¹					Total dry matter production (g plant ⁻¹)				
	Irrigation levels					Irrigation levels					Irrigation level				
	I_1	I_2	I_3	I_4	Mean	I_1	I_2	I_3	I_4	Mean	I_1	I_2	I_3	I_4	Mean
Varieties															
V_1	33.20 ^l	34.10 ^l	35.40 ^k	37.16 ^j	34.97 ^e	12.87 ^b	13.93 ^a	14.17 ^a	14.43 ^a	13.85 ^a	25.14 ^g	27.74 ^{fg}	28.15 ^{e-g}	32.14 ^{b-c}	28.29 ^c
V_2	38.91 ^{gh}	39.16 ^{f-h}	40.07 ^{ef}	41.81 ^c	39.99 ^c	11.30 ^{g-i}	11.47 ^{f-h}	11.93 ^{d-f}	12.33 ^{b-e}	11.76 ^c	30.93 ^{d-f}	35.67 ^{ab}	36.81 ^a	35.28 ^{a-c}	34.67 ^a
V_3	41.32 ^{cd}	42.20 ^{bc}	43.23 ^b	44.40 ^a	42.79 ^a	11.08 ^{b-i}	11.50 ^{f-h}	11.77 ^{c-g}	11.83 ^{c-g}	11.54 ^c	31.13 ^{c-f}	34.79 ^{a-d}	35.59 ^{ab}	35.15 ^{a-d}	34.16 ^a
V_4	37.44 ^{ij}	38.37 ^{hi}	39.47 ^{e-g}	39.90 ^{e-g}	38.79 ^d	10.83 ⁱ	11.03 ^{hi}	11.94 ^{d-f}	12.43 ^{b-d}	11.56 ^c	26.78 ^g	31.23 ^{c-f}	32.68 ^{e-d}	35.91 ^{ab}	31.65 ^b
V_5	40.37 ^{dc}	41.55 ^c	41.57 ^c	43.17 ^b	41.66 ^b	12.03 ^{d-f}	12.27 ^{c-i}	12.50 ^{b-d}	12.77 ^{bc}	12.39 ^b	28.11 ^{e-g}	32.22 ^{b-c}	35.74 ^{ab}	36.36 ^{ab}	33.11 ^{ab}
Mean	38.25 ^d	39.08 ^c	39.95 ^b	41.29 ^a		11.62 ^d	12.04 ^c	12.46 ^b	12.76 ^a		28.42 ^b	32.33 ^{ab}	33.79 ^a	34.97 ^a	
SV															
Irrigation			SEm±					SEm±					SEm±		
Varieties			0.12					0.05					0.89		
$I \times V$			0.17					0.09					0.65		
			0.35					0.18					1.30		

recorded significantly higher hundred seed weight (V_3 -28.75 g) over rest of the treatments followed by variety ICCV-2 (V_5 -22.83 g). These might be due to varietal character. These results agree with those of Hamed [4] and Mirza et al. [5] on chickpea.

Interaction effect of irrigation levels with hydrogel application and varieties on growth and yield components of chickpea

Interaction effect of irrigation levels and varieties was significantly differed (Table 3). Among the interaction treatments Annigeri-1 variety with 0.6 IW/CPE + 2.5 kg ha⁻¹ hydrogel (I_4V_1) was recorded significantly higher grain and haulm yield (2152 and 2086 kg ha⁻¹, respectively) which were on par with Annigeri-1 with 0.6 IW/CPE (I_3V_1 -1888 and 2058 kg ha⁻¹, respectively), JG-11 with 0.6 IW/CPE (I_3V_2 -1981 and 2073 kg ha⁻¹-respectively), JAKI-9218 with 0.6 IW/CPE + 2.5 kg ha⁻¹ hydrogel (I_4V_4 -1927 and 2057 kg ha⁻¹, respectively), ICCV-2 with 0.6 IW/CPE + 2.5 kg ha⁻¹ hydrogel (I_4V_5 -2075 and 2067 kg ha⁻¹, respectively) and ICCV-2 with 0.6 IW/CPE (I_3V_5 -1986 and 2038 kg ha⁻¹, respectively). Interaction effect of irrigation levels and varieties with respect to harvest index was not significant. However Annigeri-1 variety with 0.6 IW/CPE + 2.5 kg

ha⁻¹ hydrogel (I_4V_1) recorded highest harvest index (50.78%) over rest of the interaction treatments. The number of pods per plant and seed weight per plant was significantly influenced by interaction effect of irrigation levels and varieties. Among interaction treatments Annigeri-1 variety with 0.6 IW/CPE + 2.5 kg ha⁻¹ hydrogel (I_4V_1) was recorded significantly higher number of pods per plant and seed weight per plant (68 and 12.53 g) over rest of the treatments. The hundred seed weight was significantly influenced by interaction effect of irrigation levels and varieties. Among interaction treatments BGD-103 variety with 0.6 IW/CPE + 2.5 kg ha⁻¹ hydrogel (I_4V_3) was recorded significantly higher hundred seed weight (29.17 g) over rest of the treatments except the BGD-103 with 0.6 IW/CPE (I_3V_3 -28.83 g), BGD-103 with 0.4 IW/CPE + 2.5 kg ha⁻¹ hydrogel (I_2V_3 -28.83 g) and BGD-103 with 0.4 IW/CPE (I_1V_3 -28.17 g) with which it was on par. The higher seed yield in Annigeri-1 was mainly due to significantly higher growth and yield components and difference in seed yield of chickpea genotype as the timing of irrigation coincided with flowering in 0.6 IW/CPE and this was also reported by Nagarajaiah [3].

From the present investigation it can be concluded that by growing of chickpea variety Annigeri-1 with 0.6 IW/CPE + 2.5 kg ha⁻¹ hydrogel will help

providing adequate moisture to plant during the critical stages of crop growth which increases the growth and yield parameters.

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