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Effect of date of sowing and irrigation on seed yield, yield attributes and water use of Chickpea (*Cicer arietinum* L.) at lower Gangetic plains of West Bengal

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ABSTRACT

Chickpea, an important winter pulse crop is cultivated in Gangetic plains of West Bengal after harvesting of kharif rice. This field experiment was conducted at Kalyani (22°56□N latitude and 89°E longitude), West Bengal for two consecutive years of 2005-06 and 2006-07 during winter season to study the effect of date of sowing and irrigation regime on seed yield, yield attributes and water use of chickpea. Results revealed that 1st date of sowing (20th Novemver) was found better in terms of seed yield (1454.83 kg ha^{-1}). Number of pods plant^{-1} (35.95), seeds pod^{-1}(2.07) and test weight (166.81g) were higher at 20th Novemver sowing. Seed yield of chickpea significantly influenced by irrigation and recorded maximum of 1578.20 kg ha^{-1} with two irrigations at branching and pod formation stage. Two irrigations at branching and pod formation also recorded significantly higher pods plant^{-1} (40.67), seeds per pod (2.09) and test weight (172.28). Higher AET (actual evapo-transpiration) was recoded with the increasing irrigation frequency, but water use efficiency is not proportional with irrigation level.

Key words: Chickpea, date of sowing, irrigation, water use, yield

Chickpea (*Cicer arietinum* L.) is generally grown in winter season after harvesting of *kharif* rice with the stored soil moisture. Its sowing time varies with the harvesting of preceding rice crop. Date of sowing plays an important role in yield and yield attributes of chickpea (Thakur *et al.*, 1998 and Saini and Faroda, 1997). Delayed sowing reduces growing period, hastens maturity and ultimately reduces yield. Soil moisture plays a critical role in chickpea production influencing the plant growth right from the seedling establishment to maturity. Yield and yield attributing characters of chickpea are significantly influenced by the level of irrigation (Maity and Jana, 1987). Hence, the present experiment was taken to study the response of chickpea under different levels of irrigation based on critical growth stage of the crop.

MATERIALS AND METHODS

The experiment was conducted at Kalyani of lower Gangetic plains of West Bengal during winter season of 2005-06 and 2006-07. The soil type of the experimental site was sandy loam in texture and grouped under Entisol, having 0.59% organic carbon, 127.80 kg ha^{-1} available nitrogen, 22.24 kg ha^{-1} P_2O_5 and 145.00 kg ha^{-1} K_2O. The field capacity, permanent wilting point and bulk density of different layers are given below:

Table 1: Field capacity, wilting point and bulk density of experimental site

Soil depth (cm)	Field capacity (mm)	Wilting point (mm)	Bulk density (g c.c.$^{-1}$)
0-15	41.18	12.44	1.43
15-30	40.52	12.70	1.46
30-45	39.56	12.74	1.49
45-60	37.55	12.96	1.49

The field experiment was laid out in split-plot design keeping 2 dates of sowing (20th November and 6th December) in main plots and 4 irrigation regimes (rainfed, one irrigation at branching, two irrigations at branching and pre-flowering and two irrigations at branching and pod formation stage) in sub-plots and replicated four times. A measured amount of 30 mm water was given in each irrigation. Water was applied using a delivery pipe with known flow rate. Duration of irrigation in any plot determined on the basis of volume of water [Area of the plot × depth of irrigation (30 mm)] needed to irrigate the plot. During the 1st year of experiment crop did not receive any rainfall, however, the 2nd year crop received an amount of 84.5 mm of rainfall. As a result irrigation at pod formation stage was not required at 2nd date of sowing during 2006-07.

RESULTS AND DISCUSSION

Date of sowing

Chickpea crop was significantly influenced by date of sowing in both the experimental years. Highest number of pods per plant (36.34, 34.88 and 35.95), number of seeds per pod (1.77, 1.69 and 1.73) and test weight (157.37 g, 166.47 g and 162.26) respectively were recorded with the first date of sowing for 2005-06, 2006-07 and pooled mean of two years. Significant higher grain yield of 1474.24 kg ha^{-1} and 1442.58 kg ha^{-1} respectively for first and second year was recorded with 1st date of sowing (Table 2). Such significant variation of seed yield and yield attributing characters attributed to the variation of weather factors, which shorten the growing period due the delayed sowing. This result was corroborated with the findings of Dixit *et al.* (1993) and Saini and Faroda (1997).

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Table 2: Effect of date of sowing and irrigation regime on yield and yield attributes

Treatment	Pods plant^{-1}			Seeds pod^{-1}			1000-seed wt. (g)			Seed yield (kg ha^{-1})		
	2005-06	2006-07	Pooled	2005-06	2006-07	Pooled	2005-06	2006-07	Pooled	20005-06	2006-07	Pooled
Date of sowing												
20th Nov.	36.34	34.88	35.95	1.77	1.69	1.73	157.37	166.47	162.26	1474.24	1442.58	1454.83
6th Dec.	30.37	27.89	29.47	1.48	1.54	1.51	126.13	154.24	140.52	1362.95	1038.83	1199.79
LSD(0.05)	**4.97**	**5.36**	**0.61**	**0.18**	**0.14**	**0.12**	**15.18**	**9.44**	**3.59**	**95.53**	**158.85**	**56.27**
Irrigation regime												
I_o	21.96	21.22	21.92	1.45	1.44	1.44	124.11	145.61	135.19	928.85	896.23	910.66
I_b	31.69	36.65	34.59	1.59	1.72	1.69	132.36	168.62	150.91	1407.19	1417.00	1411.51
I_{bf}	36.21	30.53	33.65	1.70	1.52	1.62	146.35	155.22	151.06	1595.63	1233.00	1408.86
I_{bp}	43.56	37.14	40.67	1.78	1.78	1.77	164.20	171.97	168.40	1742.71	1417.00	1578.20
LSD(0.05)	**3.77**	**3.85**	**2.83**	**0.16**	**0.13**	**0.10**	**11.94**	**7.45**	**8.13**	**78.11**	**103.66**	**63.84**

** I_o – Rainfed, I_b – Irrigation at branching, I_{bf} – Irrigation at branching and pre-flowering, I_{bp} – Irrigation at branching and pod formation*

Analysis of table-2 reveals that two irrigations at branching and pod formation recorded significantly higher pods plant^{-1} of 43.56, 37.14 and 40.67 over the other irrigation regimes during 2005-06, 2006-07 and pooled of two years respectively. However, during 1st year of experiment, one irrigation at branching and two irrigations at branching and pre-flowering did not show any significant difference. Two irrigations at branching and pod formation proved to be better regarding seeds pod^{-1} (1.78 during both the years) and 1000-seed weight (164.20, 171.97 and 168.40g during 2005-06, 2006-07 and pooled, respectively). Two irrigations at branching and pod formation (I_{bp}) recorded highest grain yield of 1742.71 kg ha^{-1} during the first year followed by I_{bf}, I_b and I_o. But during the 2nd year of experiment the yield was at par in I_b and I_{bp} treatments but yield was significantly higher than I_o and I_{bf}. The pooled mean of two years also showed significant variation among different irrigation regimes and two irrigations at branching and pod formation recorded the highest yield (1578.20 kg ha^{-1}). This type of variation of yield and yield attributing characters was due to the fact that all the growth stages of chickpea are not equally sensitive to the moisture stress. Similar type of results were reported by Singh and Dixit (1992) and Kumar (2008).Treatment variation among the two experimental year was due to the fact that the 1st year did not receive any rainfall, whereas 2nd year crop received a copious amount of rainfall (84.5 mm).

Water use

During 2005-06, irrespective of date of sowing seasonal AET (actual evapotranspiration) was at the lowest level under rainfed situation viz. 115.80 mm and 113.10 mm for 1st and 2nd date of sowing (Table 3), respectively. The same was increased by 17.60%, 35.55% and 35.22% for I_b, I_{bf} and I_{bp} treatment in 1st date of sowing, whereas, in 2nd date of sowing there was 19.03%, 40.53% and 47.30% increase in AET with I_b, I_{bf} and I_{bp} treatments over I_o.

Table 3: Seasonal actual evapotranspiration (SET, mm) and water use efficiency (WUE, kg m^{-3}) calculated by soil moisture depletion method during 2005-06 and 2006-07 crop seasons

Treatment	SET		WUE	
	2005-06	2006-07	2005-06	2006-07
D_1I_o	115.80	154.92	0.88	0.67
D_1I_b	136.18	175.49	1.07	0.95
D_1I_{bf}	156.97	183.46	1.01	0.78
D_1I_{bp}	156.58	189.46	1.15	0.86
D_2I_o	113.10	162.50	0.74	0.46
D_2I_b	134.62	178.51	1.01	0.66
D_2I_{bf}	158.94	197.23	0.99	0.52
D_2I_{bp}	166.60	178.82	1.00	0.67

D_1- First date of sowing, D_2- Second date of sowing, I_o- Rainfed, I_b- One irrigation at branching, I_{bf}- Two irrigations- at branching and pre-flowering, I_{bp}- Two irrigations- at branching and pod initiation. D_2I_b and D_2I_{bp} were identical during 2006-07, as second irrigation at pod formation was ruled out due to rainfall in D_2I_{bp}.

Analysis of table-3 also reveals that during 2006-07 irrespective of date of sowing seasonal AET was at the lowest level under rainfed situation (154.92 mm and 162.50 mm for 1st and 2nd date of sowing, respectively). The same was increased by 13.28%, 18.42% and 22.00% for I_b, I_{bf} and I_{bp} treatment respectively for 1st date of sowing. These increases were 9.85%, 21.37% and 10.04%, respectively for I_b, I_{bf} and I_{bp} treatments at second date of sowing. This type of increase in SET (seasonal evapotranspiration) with the increase in soil moisture regime, in both the experimental years, was due to increase in soil

evaporation as well as transpiration. The results of this experiment confirm the results obtained by Nayar and Singh 1985. The overall increase in SET for 2nd year in comparison with the 1st year was due to a notable amount of rainfall (84.50 mm) during 2nd year.

During 2005-06, irrespective of date of sowing WUE (water use efficiency) was at lowest level under rainfed situation *viz.,* 0.88 kg m^{-3} and 0.74 kg m^{-3} for 1st and 2nd date of sowing, respectively (Table 3). The same was increased by 20.57%, 14.50% and 30.56% respectively for I_b, I_{bf} and I_{bp} treatment for 1st date of sowing. For 2nd date of sowing, these increases were 37.08%, 35.19% and 36.45%, respectively for I_b, I_{bf} and I_{bp} treatment.

During 2006-07, irrespective of date of sowing seasonal WUE was at lowest level under rainfed situation *viz.*, 0.67 kg m^{-3} and 0.46 kg m^{-3} for 1st and 2nd date of sowing, respectively (Table 3). The same was increased by 41.52%, 17.09% and 28.58% for I_b, I_{bf} and I_{bp} treatment for 1st date of sowing. These increases were 43.03%, 13.09% and 46.39%, respectively for I_b, I_{bf} and I_{bp} treatment in second year. It is to be noted that at 2nd date of sowing during 2006-07 2nd irrigation at pod initiation stage in I_{bp} treatment was not required, as a result I_b and I_{bp} treatments here are identical. In general, increase in yield was observed due to increase in irrigation level. The results reaffirmed the study by Parihar (1990), Tomar *et al.* (1993), Nimje (1991), Kang *et al.* (2004), Ray (2010) and Ray *et al.* (2010). Though seed yield of chickpea increases with increase in irrigation, but magnitude of increase varies with the time of application. This is due to the fact that pod formation stage is more sensitive than pre-flowering stage. Not only that after some threshold limits this increase in yield was not proportional with the increase in irrigation level, rather yield may decrease. This was the reason for maximum WUE under I_b moisture regime (1.01 kg m^{-3}) during 2005-06 at 2nd date of sowing and during 2006-07 at 1st and 2nd date of sowing (0.95 and 0.66 kg m^{-3} respectively) (Table 3). Similar study under taken by Dixit (1992) also supports the above findings.

It can be concluded from the experiment that sowing of chickpea during mid November along with two irrigations at branching and pod formation under lower Gangetic plains of West Bengal gives the maximum grain yield.

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