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Water use in chickpea (*Cicer arietinum* L.) in the Gangetic alluvial zone of West Bengal*

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ABSTRACT

A field experiment was conducted during the post-monsoon season for two consecutive years 2005-06 and 2006-07 to study the effect of date of sowing and irrigation regime on yield and water use in chickpea (*Cicer arietinum* L.). The results revealed that 1st date of sowing (20 November) recorded the maximum seed yield (1474.24 and 1442.58 kg ha^{-1} during 1st and 2nd year, respectively) as well as plant height and dry matter accumulation. The daily moisture use rate of chickpea during early vegetative stage was slightly higher with earlier sowing as compared to that of late sowing in both the experimental years. But during reproductive stage i. e. after flowering, late sown crop recorded higher moisture use. But the overall consumptive use was higher under late sown condition. Application of two irrigations at branching and pod formation resulted in higher seed yield, whereas the consumptive use was higher when the irrigation was applied at branching and flower initiation. Total moisture use was lowest under rainfed condition that led to lower seed as well as biomass yield. However, the chance of rainfall (*Kal Baisakhi*) during March in the new alluvial zone of West Bengal must be taken into consideration while scheduling irrigation during pod formation.

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

Chickpea (*Cicer arietinum* L.) is an important pulse crop that responds to irrigation (Singh and Dixit, 1992; Krishnamurthy and Sreeramulu, 2007; Sharma *et al.*, 2007). Besides irrigation schedule, sowing time is equally important to realize the maximum yield potential of this crop (Thakur *et al.*, 1998). Delay in sowing reduces growing period, hastens maturity and ultimately reduces the yield (Singh *et al.*, 2008). As judicious water use and appropriate time of sowing are pre-requisites for successful cultivation of chickpea, a field experiment was conducted to find out water use and yield under different irrigation regimes and dates of sowing.

MATERIALS AND METHODS

The experiment was laid out at BCKV Research Farm, Kalyani, West Bengal during post-monsoon season in two consecutive years 2005-06 and 2006-07 in split plot design with date of sowing as main plot treatment (20 November and 6 December) and irrigation as sub-plot treatment (I_o–Rainfed, I_b–One irrigation at branching, I_{bf}–Two irrigations at branching and pre-flowering and I_{bp}–Two irrigations at branching and pod formation). 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} phosphorus and 145.00 kg ha^{-1} potash. The field capacity, permanent wilting point and bulk density of different layers are given in Table 1. Recommended agronomic practices were followed to raise the crop. In 2005-06, there was no rainfall during the crop period, but crop received 84.5 mm of rainfall during the 2nd experimental year (during 84-107 and 64-86 DAS for 1st and 2nd date of sowing, respectively).

The moisture studies were carried out to find out the water use of crop. Soil moisture content at 0-15, 15-30, 30-45 and 45-60 cm depth was determined by gravimetric method. Samplings were done at – before sowing, two days after each irrigation, after notable rainfall (= 20), before the next

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.)
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

*Papers presented at and reviewed for proceeding of national seminar on "Agrometeorology-Needs, Approaches and Linkages for Rural Development" held at CCSHAU, Hisar during 26-27 November 2009.

Table 2: Influence of date of sowing and irrigation on growth and yield of chickpea

Treatment	Plant height (cm)		DMA at harvest ($g\ m^{-2}$)		Seed yield ($kg\ ha^{-1}$)		Biomass yield ($kg\ ha^{-1}$)	
	2005-06	2006-07	2005-06	2006-07	2005-06	2006-07	2005-06	2006-07
Date of sowing								
D_1	49.11	49.47	385.13	406.44	1474.24	1442.58	3851.27	4064.44
D_2	40.33	44.66	326.88	315.93	1362.95	1038.83	3268.77	3159.32
C. D. (P=0.05)	7.46	4.07	28.72	39.67	95.53	158.85	287.22	396.69
Irrigation								
I_o	36.00	40.72	220.08	242.16	928.85	896.23	2200.83	2421.56
I_b	42.69	46.63	361.20	381.69	1407.19	1416.98	3612.00	3816.88
I_{bf}	51.22	52.22	430.75	423.11	1595.63	1233.00	4307.54	4231.15
I_{bp}	48.97	48.69	411.97	397.79	1742.71	1416.61	4119.71	3977.94
C. D. (P=0.05)	4.77	3.79	17.82	25.67	78.11	103.66	178.20	256.68

Table 3: Influence of date of sowing and irrigation on consumptive water use (CWU) rate (mm/day) and overall CWU (mm) in chickpea

Treatment	Sowing to branching		Branching to flowering		Flowering to pod formation		Pod formation to maturity		Overall CWU (mm)	
	2005-06	2006-07	2005-06	2006-07	2005-06	2006-07	2005-06	2006-07	2005-06	2006-07
Date of sowing										
D_1	0.76	0.83	0.97	1.33	1.24	1.42	1.20	1.68	141.38	175.83
D_2	0.74	0.79	0.91	1.34	1.50	1.63	1.16	1.80	143.32	179.27
Irrigation										
I_o	0.75	0.81	0.84	1.20	1.19	1.34	0.89	1.58	114.45	158.71
I_b	0.76	0.82	1.00	1.36	1.33	1.54	1.05	1.72	135.40	177.00
I_{bf}	0.75	0.82	0.94	1.40	1.62	1.72	1.31	1.81	157.96	190.35
I_{bp}	0.75	0.80	0.99	1.38	1.35	1.51	1.48	1.85	161.59	184.14

irrigation and immediately after harvesting. Crop water use was computed from soil water content as described by Dastane (1972).

Canopy temperature (Tc) was recorded with the help of infrared thermometer and the ambient temperature (Ta) was recorded by using mercury in glass thermometer. CATD (canopy air temperature difference) values = Tc – Ta, were plotted against their corresponding soil moisture values to find out the relation between CATD value and soil moisture content.

Yield attributes and other biometric observations were taken from 10 selected plants from each plot. Seed and biological yields were recorded from individual plots and expressed in $kg\ ha^{-1}$.

RESULTS AND DISCUSSION

Growth and yield

The results revealed that higher plant height (49.11 and 49.47 cm during 1st and 2nd year, respectively) and dry matter accumulation (385.13 and 406.44 $g\ m^{-2}$ during 1st and 2nd year, respectively) were observed with 1st date of sowing. Similarly, significantly higher seed yield (1474.24 and 1442.58 $kg\ ha^{-1}$ during 1st and 2nd year, respectively) and biomass yield (3851.27 and 4064.44 $kg\ ha^{-1}$ during 1st and 2nd year, respectively) were also recorded with 1st date of sowing (Table 2). Dixit *et al.* (1993) and Saini and Faroda (1997) have also recorded higher seed yield from early sowing.

Application of two irrigations at branching and pod formation resulted in higher seed yield, whereas two

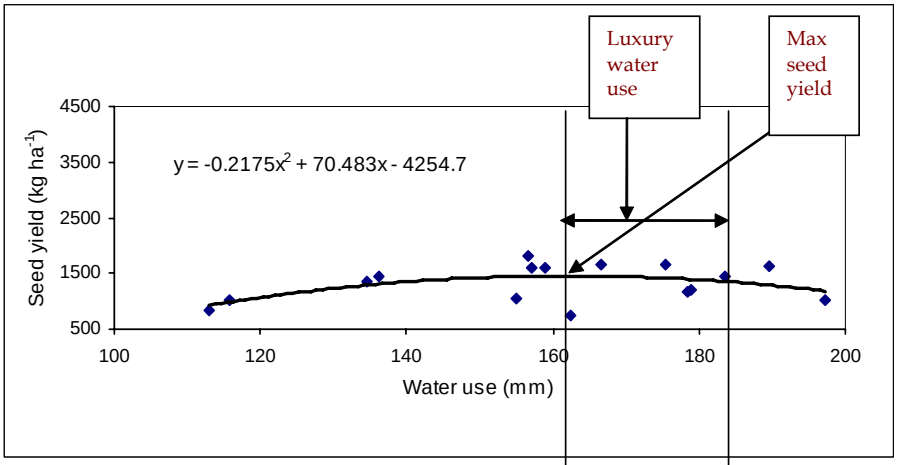

Fig. 1: Seed yield as a function of water use.

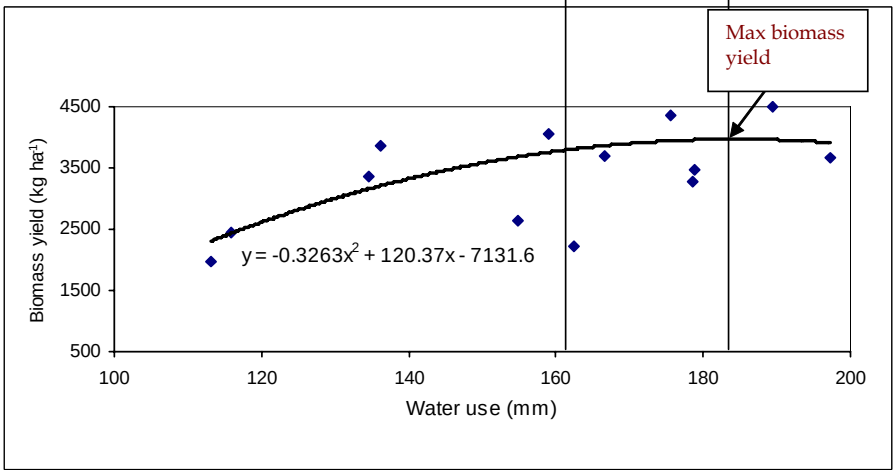

Fig. 2: Biomass yield as a function of water use

irrigations at branching and pre-flowering resulted in higher biomass yield (Table 2). The results obtained in this experiment reaffirm the results obtained by Singh and Dixit (1992), Dixit *et al.* (1993), Tiwari and Tripathi (1995) and Sharma *et al.* (2007). But higher plant height and dry matter accumulation at harvest were observed with two irrigations at branching and pre-flowering. This might be due to the fact that irrigation at pod formation stage was more critical for reproductive growth than irrigation at pre-flowering, whereas irrigation at pre-flowering stage favoured vegetative growth.

Water use

The results revealed that the overall moisture use in 2006-07 was higher than that of 2005-06. The seed and biomass yield followed the reverse trend that is indicated by a drastic reduction in moisture use efficiency in the second year. This was due to the fact that during 1st year, controlled water management favoured the partitioning of photosynthates, whereas during second year, rainfall at advanced stage of crop stimulated vegetative growth. The daily moisture use rate of chickpea during early vegetative stage was slightly higher with earlier sowing as compared to that of late sowing in both the experimental years. But during reproductive stage i. e. after flowering, late sown crop recorded higher moisture use. But the overall consumptive use was higher under late sown condition in both the experimental years (Table 3).

Application of two irrigations at branching and pod formation resulted in higher seed yield, whereas the consumptive use was higher when the irrigation was applied at branching and flower initiation. Total moisture use was lowest under rainfed condition that led to lower seed as well as biomass yield (Table 3).

Looking to the significant association of seed yield and biomass yield of chickpea with water use, curvilinear relationships have been developed (Figs. 2 and 3). From this

relation, it can be stated that optimum water for maximum seed and biomass yield is 162.03 and 184.45 mm, respectively. In chickpea, luxuriant consumption water i. e. beyond 162.03 mm was observed when higher amount of irrigation or rainfall received.

CONCLUSION

It can be concluded from the present study that the application of two irrigations at branching and pod formation is appropriate for higher grain yield and sowing of chickpea at the middle of November is ideal for seed production under Gangetic alluvial zone of West Bemgal. However, the chance of rainfall (*Kal Baisakhi*) during the month of March in the Gangetic alluvial zone of West Bengal must be taken into consideration while scheduling irrigation during pod formation.

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