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Effect of Irrigation and Nitrogen Levels on Clusterbean *(Cymopsis tetragonoloba)* in IGNP Stage-II

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ABSTRACT

An experiment was carried out at Bikaner, Rajasthan during kharif season of 2016 to see the effect of irrigation and nitrogen levels on clusterbean *(Cymopsis tetragonoloba)* in IGNP stage-II. The treatment comprising three levels of irrigation (100, 200 and 300 mm) and four levels of nitrogen (0, 20, 40 and 60 kg N ha^{-1}) comprising a total of twelve treatment combinations in split plot design with four replications. Increasing level of irrigation from 100 mm to 200 mm increased the plant height, dry matter accumulation, yield attributing trait and yield of clusterbean over 100 mm and remained at par with 300 mm. Application of 40 kg N ha^{-1} produced significantly highest yield height, dry matter accumulation, yield attributing trait and yield of clusterbean cover control and 20 kg N ha^{-1} but it remained at par with 60 kg N ha^{-1}. Interaction effect of irrigation and nitrogen levels was also found significant for seed, stover and biological yield of clusterbean and highest values of these parameters were recorded with 200 mm irrigation in combination with 40 kg N ha^{-1}.

Key words: Clusterbean, Irrigation, Nitrogen, Yield

Rajasthan is predominantly a rainfed state with precipitation being major source of annual renewable water supply. With the rapidly increasing population and rising standards of living as well as exponential growth of industrialization, the water availability in the state is decreasing at an alarming rate, and water scarcity is growing rapidly. Scarcity of water resources and growing competition for water in many sectors reduce its availability for irrigation. Effective management of water for crop production in water scarce areas requires efficient approaches for improving water productivity. These include effective management practices, growing high value water efficient crops and cropping systems. The crops grown in Indra Gandhi Nahar Project (IGNP) stage II are high water requiring and farmers use excess irrigation for growing the crops. Therefore, technological interventions are required to improve crop water productivity of the area. Groundnut and clusterbean are the major *kharif* season crops of IGNP stage II. These crops not only play a great role in economic growth of the farmers of this region, but also contribute a lot in India economy. India accounts about 80 per cent of the world clusterbean production. Total area under the crop in India was around 59.62 lakh hectares with an annual production of 35.87 lakh tones (Mukesh *et al.* 2018). About 85 per cent of total clusterbean production is contributed by Rajasthan and

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Haryana states, only. In Rajasthan, total area under clusterbean was 46.30 lakh ha production was 27.47 lakh tones contributing 70 per cent of total clusterbean (Mukesh et al. 2018). Among all nutrients, crop demand for N is greatest. All plants need N to grow, develop leaves and branches, carry out photosynthesis and produce proteins which are compounds of nitrogen. Moreover, the level of nitrogen fertilization and irrigation is very important to increase the fertilizer efficiency, decrease the loss of water and improve water productivity without compromising the crop yield. Hence, looking to the above facts, an experiment entitled to see the "Effect of Irrigation and Nitrogen Levels on growth and Yield of Clusterbean in IGNP Stage II" was under taken.

Materials and Methods

An experiment was carried out during kharif season of 2016 at Bajju, (072° 47'79"E longitude and 28° 14'23"N latitude and 234.7 m above mean sea) Bikaner Rajasthan, India. The field experiment was laid out in kharif season 2016 with three levels of irrigation *i.e.* 100, 200 and 300 mm and four levels of nitrogen *i.e.* 0, 20, 40 and 60 kg N ha^{-1} in split plot design with four replications. Urea was used as the source of nitrogen. Half dose of nitrogen was applied as a basal dose through urea prior to sowing. The remaining half dose of nitrogen was top dressed through urea at first irrigation. The climate of this zone is typically arid characterized by aridity of the atmosphere and slight salinity in the rhizosphere with extremes of temperature both in summers and winters. Clusterbean crop received 131 mm of rainfall in the growing season. The soils of the area are loamy sand in texture and slightly alkaline in reaction (pH 8.1) with low in organic matter (0.13 per cent), low in available nitrogen (114.5 kg ha^{-1}), medium in available phosphorus (15.9 kg ha^{-1}) and potassium (189.2 kg ha^{-1}).

Results and Discussion

Irrigation level

Leaf area index (LAI) and dry matter accumulation of clusterbean increased significantly due to successive increase in irrigation levels from 100 mm to 200 mm and 300 mm. Application of 300 mm irrigation level recorded highest LAI and dry matter accumulation at 60 DAS and at harvest over 100 mm and 200 mm. The increase in dry matter accumulation due to 300 mm irrigation was 19.6 and 25.5 per cent over 100 mm and 5.3 and 6.9 per cent over 200 mm irrigation at 60 DAS and harvest, respectively. The possible reason for increasing leaf area index and dry matter accumulation could have been attributed to adequate supply of soil moisture to plant at

Table 1: Effect of irrigation and nitrogen levels on leaf area index and dry matter accumulation of clusterbean.

Treatments	Leaf area index (m^2 m^{-2})			Dry matter accumulation (g $plant^{-1}$)		
	30 DAS	60 DAS	Harvest	30 DAS	60 DAS	Harvest
Irrigation levels (mm)						
100	0.171	1.52	0.103	1.80	9.88	11.90
200	0.195	1.76	0.120	1.86	11.22	13.97
300	0.211	1.96	0.137	1.92	11.82	14.93
SEm±	0.005	0.04	0.004	0.05	0.23	0.28
CD (P=0.05)	0.016	0.14	0.014	NS	0.79	0.98
Nitrogen levels (kg ha^{-1})						
0	0.172	1.49	0.099	1.77	9.74	11.70
20	0.188	1.71	0.114	1.85	10.73	13.19
40	0.204	1.88	0.128	1.90	11.58	14.52
60	0.208	1.91	0.140	1.92	11.84	14.98
SEm±	0.005	0.05	0.004	0.06	0.22	0.23
CD (P=0.05)	0.016	0.14	0.013	NS	0.65	0.68

critical growth stages which might have increased the succulence in the meristematic cells and maintained turgor and favoured better proliferation of leaf buds. The results are in congruous with the findings of Behera et al. (2015), Refay (2010) and Bana *et al.* 2016. Application 200 mm irrigation significantly CGR and RGR over 100 mm and remained statistically at par with 300 mm at all recorded stage. As compared to 100 mm irrigation level, the CGR increased by 16.0 and 35.9 per cent with the application of 200 mm irrigation, between 30-60 DAS and 60 DAS-harvest, respectively. The results also corroborated with Hammad et al. 2012 and Kumar *et al.* 2015.

Seed, Stover and biological yield of clusterbean significantly increased with irrigation level up to 200 mm over 100 mm irrigation but remained at par with 300 mm irrigation level. The per cent increase in seed, stover and biological yield due to application of 200 mm irrigation was of the order of 33.2, 26.6 and 28.4 per cent over 100 mm irrigation, respectively. The adequate availability of irrigation water and plant nutrients with frequent and optimum number of irrigations

Table 2: Effect of irrigation and nitrogen levels on crop growth rate and relative growth rate of clusterbean.

Treatments	Crop growth rate (g m^{-2} day^{-1})			Relative growth rate (g g^{-1} day^{-1})	
	0-30 DAS	30-60 DAS	60 DAS-harvest	30-60 DAS	60 DAS-harvest
Irrigation levels (mm)					
100	0.060	0.269	0.092	0.985	1.03
200	0.062	0.312	0.125	1.039	1.09
300	0.064	0.330	0.141	1.060	1.12
SEm±	0.002	0.009	0.006	0.009	0.008
CD (P=0.05)	NS	0.029	0.021	0.030	0.028
Nitrogen levels (kg ha^{-1})					
0	0.059	0.265	0.089	0.978	1.02
20	0.062	0.296	0.112	1.019	1.07
40	0.063	0.323	0.133	1.053	1.11
60	0.064	0.331	0.143	1.062	1.12
SEm±	0.002	0.008	0.007	0.009	0.007
CD (P=0.05)	NS	0.024	0.020	0.026	0.021

Table 3: Effect of irrigation and nitrogen levels on seed, stover and biological yield of clusterbean.

Treatments	Yield (kg ha^{-1})		
	Seed	Stover	Biological
Irrigation levels (mm)			
100	714	1942	2655
200	951	2458	3409
300	1018	2649	3666
SEm±	32	74	103
CD (P=0.05)	111	255	356
Nitrogen levels (kg ha^{-1})			
0	676	1877	2553
20	873	2257	3130
40	996	2576	3572
60	1031	2689	3720
SEm±	26	79	102
CD (P=0.05)	74	230	295

applied might have resulted in higher yields (Sharma and Verma 2010 and Bana *et al.* 2018).

Nitrogen levels

LAI and dry matter accumulation of clusterbean significantly influenced by varying levels of nitrogen at all growth stages. Application of nitrogen up to 40 kg N ha^{-1} significantly increased the LAI and dry matter accumulation over control and 20 kg N ha^{-1} but it remained at par with 60 kg N ha^{-1}. The observed increase in dry matter accumulation due to 40 kg N ha^{-1} was to the tune of 18.9 and 24.1 per cent over control and 7.9 and 10.1 per cent over 20 kg N ha^{-1} at 60 DAS and at harvest, respectively. The overall improvement in crop growth under the influence of nitrogen fertilization might be broadly attributed to the availability of better nutritional environment in the rhizosphere as well as in the plant system (Bamboriya *et al.* 2017). This could be supported by the fact that soil of experimental field was sandy in texture with very poor available nitrogen. Similar finding also reported by Barik *et al.* (1997) and (Sukanya *et al.*, 1995). Application of 40 kg N ha^{-1} significantly increase the CGR and RGR compared to control and 20 kg N ha^{-1} and remained statistically at par with 60 kg N ha^{-1}. When compared with control and 20 kg N ha^{-1}, application of nitrogen at 40 kg N ha^{-1} significantly improved RGR by 7.7 and 8.8 per cent at 30-60 DAS and 3.3 and 3.7 per cent at 60 DAS-harvest during the consecutive growth phases, respectively. Increased periodic dry matter production due to application of nitrogen at 40 kg N ha^{-1} increased the periodic CGR and RGR at initial phase of crop growth as these growth rates are primary functions of periodic dry matter production of the crop with time. Studies conducted by other workers in groundnut also showed a significant increase in plant height with increasing levels of N from 0 to 40 kg N ha^{-1} in soils with low N status. The overall improvement in crop growth under the influence of nitrogen fertilization might be broadly attributed to the availability of better nutritional environment in the rhizosphere as well as in the plant system. The results also corroborated with (Jakhro, 1984 and Barik *et al.*, 1994). Yields of clusterbean significantly higher with 40 kg N ha^{-1} compared to control and 20 kg N ha^{-1} and remained statistically at par with 60 kg N ha^{-1}. Application of 40 kg N ha^{-1} increased the seed, stover and biological yield by 47.3, 14.1 & 37.2, 14.1 and 39.9, 14.1 per cent over control and 20 kg N ha^{-1}, respectively. Results also corroborated with Bhadoria and Kushwah (2005), Patel *et al.* (2005) and Rathore *et al.* (2007).

Interaction effect of irrigation and nitrogen

Interaction effect of irrigation and nitrogen on seed, stover and biological yield was found significant. At all the levels of nitrogen application, increase in level of irrigation increased the seed, stover and biological yield from 100 mm to 200 mm, beyond this level increase in seed yield was non-significant. Similarly, at all the levels of irrigation, increase in levels of nitrogen up to 40 kg N ha^{-1} increased the seed, stover and biological yield which remained statistically at par with 60 kg N ha^{-1}. The significantly maximum (1079 kg ha^{-1}) and minimum (594 kg ha^{-1}) seed yield was recorded with $I_{200}N_{40}$ and $I_{100}N_0$ levels, respectively. The

Table 4: Interaction effect of irrigation and nitrogen levels on seed yield of clusterbean (kg ha-1)

Nitrogen levels (kg ha^{-1})	Irrigation levels (mm)								
	Seed yield			Stover yield			Biological yield		
	100	200	300	100	200	300	100	200	300
0	594	696	738	1921	1800	1909	2515	2496	2648
20	725	878	1016	1874	2271	2626	2598	3149	3642
40	758	1079	1152	1961	2789	2978	2719	3868	4129
60	778	1150	1165	2012	2974	3082	2790	4124	4247
SEm±	44			137			176		
CD (P=0.05)	129			399			510		

highest stover yield (2789 kg ha^{-1}) was recorded with 200 mm irrigation in combination with 40 kg N ha^{-1} whereas minimum stover yield (1921 kg ha^{-1}) was observed in 100 mm irrigation in combination with no fertilizer nitrogen. The highest biological yield (3868 kg ha^{-1}) was recorded in 200 mm irrigation in combination with 40 kg N ha^{-1}. These findings are corroborated with the observations by Shirazi *et al.* 2014.

Conclusion

From the experimental findings, it can be concluded that irrigation and nitrogen levels had significant effect on growth and yield of clusterbean. The application of 200 mm irrigation with 40 kg N ha^{-1} was found most promising for getting higher leaf area index, dry matter accumulation, crop growth rate, relative growth rate, seed, straw and biological yield of clusterbean.

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