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Effect of Irrigation and Nitrogen on Growth and Yield of Rajma (*Phaseolus vulgaris* L.)

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An experiment was conducted during *rabi* season of the year 2012-13 at College Agronomy Farm, B. A. College of Agriculture, Anand Agricultural University, Anand (Gujarat) to study the effect of irrigation and nitrogen on rajma (*Phaseolus vulgaris* L.). Application of irrigation at 1.0 IW : CPE ratio and 120 kg N ha^{-1} was recorded significantly higher growth attributes and yield attributes as well as seed and straw yield. In case of treatment combination irrigation at 1.0 IW:CPE ratio in conjunction with 120 kg N ha^{-1} produced maximum seed yield (1406 kg ha^{-1}) as compared to other treatment combinations.

Key words: Rajma, Irrigation, Nitrogen.

Rajma (*Phaseolus vulgaris* L.), is also known as french bean. These common beans are annual plants that are cultivated throughout the world for their edible beans. It is highly protein rich and precious grain legume of Northern India. Though the rajma crop has a higher yield potential, its average yield is very low in plains. Rajma grows on a variety of soils ranging from light sand to heavy clay but well drained loams are the best. The crop is sensitive to salinity. Soil pH around 5.2-5.8 is optimum. The high yielding varieties have shown immense possibilities for higher yield with proper amount and time of irrigation. Irrigation to this crop is mostly based on physiological growth stages and the latest approach of scheduling irrigation through irrigation water depth: cumulative pan evaporation (IW: CPE) ratio has not yet been amply tried in almost states of India. Therefore, it is important to compare the previous methods with the latest approach of scheduling irrigation to identify the most suitable frequency, time and depth of irrigation for higher yield of rajma. The another major constraint limiting production of crop is poor fertility status of soil and nitrogen is one of the universal deficient plant nutrients in Indian soils, the loamy sand soils of semi-arid region of Gujarat. An optimum supply of nitrogen is important for vigorous growth and development of plants. Since research work on these aspects of this crop is very meagre, the present experiment was planned and conducted.

MATERIALS AND METHODS

An experiment was conducted at college agronomy farm, B. A. College of Agriculture, Anand Agricultural University, Anand (Gujarat) during *rabi* season of the year 2012-13. The soil of experimental field was loamy sand in texture, having low in organic carbon, nitrogen and phosphorus, and medium in potash. The field capacity, wilting point and bulk density of experimental field were 13.92%, 4.86% and 1.38 g/cc respectively with good drainage capacity. The treatments comprising four levels of irrigation (I_1: 0.6 IW: CPE ratio; I_2: 0.8 IW:

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CPE ratio; I_3: 1.0 IW: CPE ratio and I_4: Irrigation at branching, flowering, pod development and seed formation stages) and three levels of nitrogen (80, 120 and 160 kg ha^{-1}). The experiment was laid out in split plot design with four replications. Irrigation water of 50 mm (measured with the help of Parshall flume) was allowed to run in each plot at each irrigation. Calculated quantity of N was applied through urea in two splits. Entire quantity of P with a basal dose of 60 kg P_2O_5 ha^{-1} through diammonium phosphate was applied at sowing. Rajma was sown on November 5th, 2012 with seed rate of 100 kgha^{-1}.

RESULTS AND DISCUSSION

Effect of irrigation

Data presented in Table-1 indicated that treatment I_3 (1.0 IW: CPE ratio) recorded significantly higher plant height (37.68 cm), number of branches plant^{-1} (7.67) and significantly the highest number of pods plant^{-1} (12.41), number of seeds pod^{-1} (4.86), length of pod (9.68 cm) and seed index (47.42). Seed and straw yield of rajma significantly influenced due to irrigation treatments. Application of irrigation at 1.0 IW: CPE ratio recorded significantly the highest seed yield (1205 kg ha^{-1}) and higher straw yield (1523 kg ha^{-1}). This treatment significantly superior to the irrigation applied at 0.6 and 0.8 IW: CPE ratio for above-mentioned characters. This might be due to increase in number of irrigations applied at shorter intervals and total consumptive use of water. These situation avoided soil moisture stress and it provided very favorable conditions for soil moisture and nutrients availability to the plants and ultimately higher yield attributes and seed yield. The soil moisture stress created with the irrigation schedule with 0.6 IW: CPE at most critical growth stage of flowering was responsible for decreasing the growth characters and yield attributes, ultimately resulting in the reduction of grain and straw yield. The results corroborate the findings of Reddy *et al.*, (2010) in french bean crop.

Effect of nitrogen

Each successive increase in the level of N from 80 to 160 kg ha^{-1} significantly improved growth and yield parameters. Application of nitrogen @ 120 kg ha^{-1} recorded significantly higher plant height (37.19 cm), number of branches plant^{-1} (7.12 cm), number of pods plant^{-1} (11.37), number of seeds pod^{-1} (4.34), length of pod (8.93 cm), seed

Table 1. Effect of irrigation and nitrogen levels on growth, yield attributes and yield of rajma

Treatments	Plant height (cm)	Number of branches plant^{-1}	Number of pods plant^{-1}	Number of seeds Pod^{-1}	Length ofPod (cm)	Seed index (g)	Seed yield (kg ha^{-1})	Straw yield (kg ha^{-1})
Irrigation (I)								
I_1– 0.6 IW : CPE ratio	31.63	5.08	9.33	2.71	7.57	41.00	844	1231
I_2 – 0.8 IW : CPE ratio	35.56	7.25	10.91	3.99	8.68	44.25	1081	1482
I_3 – 1.0 IW : CPE ratio	37.68	7.67	12.41	4.86	9.68	47.42	1205	1523
I_4– Irrigation at branching, flowering,pod development and seed formation stages	35.98	7.58	9.96	3.93	8.32	44.08	1101	1435
S. Em. ±	0.78	0.19	0.28	0.10	0.17	0.33	25.69	29.21
C.D. at 5%	2.49	0.62	0.91	0.33	0.55	1.05	82.20	93.46
C.V.%	7.66	9.69	9.27	9.29	6.96	2.58	8.41	7.13
Nitrogen (N)								
N_1 – 80 kg ha^{-1}	32.02	6.56	9.41	3.09	7.93	42.75	915	1352
N_2 – 120 kg ha^{-1}	37.19	7.12	11.37	4.34	8.93	45.19	1130	1465
N_3 – 160 kg ha^{-1}	36.42	7.00	11.18	4.20	8.83	44.63	1128	1437
S. Em. ±	0.48	0.16	0.23	0.08	0.13	0.24	15.88	22.93
C.D. at 5%	1.39	0.47	0.68	0.24	0.38	0.70	46.36	66.92
C.V.%	5.42	9.28	8.76	8.41	6.05	2.18	6.00	6.37

Table 2. Interaction effect of irrigation and nitrogen on seed yield of rajma

NI	Grain yield (kg ha^{-1})		
	N_1	N_2	N_3
I_1	757	874	901
I_2	971	1093	1178
I_3	914	1406	1294
I_4	1017	1147	1139
S. Em. ±		32	
C.D. at 5%		93	

index (45.19 g). Application of 120 kg N ha^{-1} recorded higher seed (1130 kg ha^{-1}) and straw (1465 kg ha^{-1}) yield of rajma, but it was statistically at par with treatment N_3 (160 kg N ha^{-1}). The increase in the level of N was responsible for increased number of leaves/plant and leaf-area index, causing higher photosynthesis and assimilation rate with high metabolic activity and cell-division, which were responsible for the significant increase in the growth characters, yield attributes and ultimately the seed and straw yields. The findings of the investigation are in closed conformity of results obtained by Prajapati *et al*.,(2003), Moniruzzaman *et al.*, (2009) and Shubhashree *et al.*, (2011).

Interaction effects (I×N)

Interaction effect between irrigation scheduling and nitrogen levels was found significant with respect to number of pods plant^{-1}, number of seed pod^{-1}, seed and straw yields of rajma. Significantly the highest pods plant^{-1}, seed (1406 kg ha^{-1}) and straw yields (1615 kg ha^{-1}) was noted in treatment combination I_3N_2 (1.0 IW: CPE ratio + 120 kg N ha^{-1}). Whereas significantly the lowest seed yield (757 kg ha^{-1}) and lower straw yield (1193 kg ha^{-1}) was observed in treatment combination I_1N_1 (0.6 IW: CPE ratio + 80 kg N ha^{-1}). The highest number of pod plant^{-1} might be due to increasing in number of irrigations with increasing supply of nitrogen applied at shorter interval and total consumptive use of water as well as nutrient present in the presence of ample judicious quantity of water. These one avoided soil moisture stress and provided favourable condition for soil moisture and nutrient availability to the plants and ultimately higher yield attributes. This result is in agreement with Sushant *et al.* (1999). Increasing higher seed pod^{-1} might be due to profuse branching due to nitrogen fertilization coupled with increasing net photosynthesis in the presence of required quantity of water. For increasing the seed and straw yield might be due to increase in yield attributed to more vigorous crop growth and higher order of yield attributes under frequent irrigation with adequate supply of nitrogen as the atmosphere had high demand of evapo-transpiration and nutrient during crop period and this results in increased seed yield.The results are in close conformity with those of Behura *et al.* (2008).

CONCLUSION

From the above results, it can be concluded that for securing higher seed yield of rajma, it is advisable to irrigate the crop at 1.0 IW: CPE ratio in conjunction with 120 kg N ha^{-1}.

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