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EFFECT OF IRRIGATION AND NUTRIENT MANAGEMENT ON PRODUCTIVITY OF KABULI CHICKPEA (*Cicer kabulium*)

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ABSTRACT

An experiment was conducted at College of Agriculture, Nagpur during *rabi* season of 2016-17 on chickpea in spilt plot design with twelve treatment combinations consisting of three main plot treatments on irrigation viz., 0.6 IW/CPE ratio (I_1), 0.8 IW/CPE ratio (I_2) and 1.0 IW/CPE ratio (I_3) and four sub plot treatments on nutrient management, viz., 75% RDF + *Rhizobium* (Seed treatment @ 25 g kg^{-1}) + PSB (Soil application @ 5 kg ha^{-1}) (N_1), 100 % RDF + *Rhizobium* (Seed treatment @ 25 g kg^{-1}) + PSB (Soil application @ 5 kg ha^{-1}) (N_2), 100 % RDF + *Rhizobium* (Seed treatment @ 25 g kg^{-1}) + PSB (Seed treatment @ 25 g kg^{-1}) (N_3) and 125% RDF (N_4) replicated thrice. Two irrigations were applied to the crop following treatmentwise IW/CPE ratio. Growth characters and yield attributes viz., plant height, number of branches plant^{-1}, number of root nodules plant^{-1} and dry matter accumulation plant^{-1}, number of pods plant^{-1}, number of seeds plant^{-1}, test weight, seed and straw yield plant^{-1} (g), seed and straw yield (kg ha^{-1}) and economics i.e. GMR (77812 Rs.ha^{-1}), NMR (52851 Rs.ha^{-1}) and B:C ratio (3.65) were significantly more with the application of irrigation at 0.6 IW/CPE ratio. In case of nutrient application, the growth and yield contributing characters, yield and monetary returns were significantly increased due to application of nutrient 100 % RDF + *Rhizobium* (Seed treatment @ 25 g kg^{-1}) + PSB (Soil application @ 5 kg ha^{-1}) (N_2) which was at par with 100 % RDF + *Rhizobium* (Seed treatment @ 25 g kg^{-1}) + PSB (Seed treatment @ 25 g kg^{-1}) (N_3) and 125% RDF (N_4). Based on present investigation it can be inferred that application of irrigation at 0.6 IW/CPE ratio and 100 % RDF + *Rhizobium* (Seed treatment @ 25 g kg^{-1}) + PSB (Soil application @ 5 kg ha^{-1}) (N_2) yielded maximum seed and straw and economics of chickpea.

(Key words: Chickpea, irrigation, nutrient management, economics)

INTRODUCTION

Pulses are considered as life blood of agriculture. The United Nation declared during year 2016 as "International year of Pulses" to heighten public awareness of the nutritional benefits of pulses as part of sustainable food production aimed at food security and nutrition. Gram (*Cicer kabulium* L.) is world's important pulse crop occupying third position among pulses. Statistical data published by agricultural statistic division (2014-15) revealed that in India, chickpea covers an area of 8 million hectares with the production of 7.1 million tonnes and productivity of 885 kg ha^{-1}. According to the International Crops Research Institute for the Semi-Arid Tropics chickpea seeds contain on an average 23% protein, 64% total carbohydrates (47% starch, 6% soluble sugar), 5% fat, 6% crude fiber and 3% ash.

Scheduling of irrigation on the basis of pan evaporation (IW/CPE ratio) can suitably determine the days between the irrigations, which may helpful and understandable to the farmers. Organic additives can be used to promote the development of beneficial organisms in the soil. Bio-fertilizers are cheaper, eco-friendly and based on renewable energy sources has gained momentum in recent years to supplement the parts of chemical fertilizers (Meena *et al*., 2015a). *Rhizobium* and PSB are beneficial for root nodule formation collectively known as rhizobia, as potential microbial inoculants have been convincingly emphasized in recent years for its nitrogen fixing ability (Meena *et al*., 2015b).

MATERIALS AND METHODS

A field experiment was conducted at Agronomy farm, College -of Agriculture, Nagpur during *rabi* season of 2016-17. The experiment was laid out in split plot design with three different levels of irrigation *viz.,* 0.6, 0.8 and 1.0 IW/CPE ratio as main plot treatments and four sub plot treatments on nutrient management, viz. 75% RDF + *Rhizobium* (Seed treatment @ 25 g kg^{-1}) + PSB (Soil application @ 5 kg ha^{-1}), 100 % RDF + *Rhizobium* (Seed treatment @ 25 g kg^{-1}) + PSB (Soil application @ 5 kg ha^{-1}), 100 % RDF + *Rhizobium* (Seed treatment @ 25 g kg^{-1}) + PSB (Seed treatment @ 25 g kg^{-1}) and 125% RDF as another factor forming twelve treatment combinations replicated

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thrice. Two irrigations were applied to the crop considering treatmentwise IW/CPE ratio. The soil of experimental plot was vertisol, low in available nitrogen (263.20 kg ha^{-1}), medium in phosphorus (20.12 kg ha^{-1}) and organic carbon (0.58 %), very high in available potash (414.12 kg ha^{-1}) and slightly alkaline in reaction (pH 7.9). The crop variety PKV Kabuli-2 was used with gross plot size of 4.5 m × 4.8 m and net plot size of 3.6 m × 4.2 m. In order to represent the treatment effect, five plants from each net plot were selected randomly, labeled properly. The growth attributing characters *viz.,* plant height, number of branches $plant^{-1}$, number of root nodules $plant^{-1}$ and dry matter accumulation $plant^{-1}$ were recorded at harvest and yield attributing characters and yield *viz.,* number of pods $plant^{-1}$, number of seeds $plant^{-1}$, test weight, seed and straw yield $plant^{-1}$ (g), seed and straw yield (kg ha^{-1}) were also recorded at harvest. The gross monetary and net monrtary returns along with B:C ratio were worked out to study the economics.

RESULTS AND DISCUSSION

Effect on growth characters

The data pertaining to various growth characters studied viz., plant height, number of branches $plant^{-1}$, number of root nodules $plant^{-1}$ and dry matter accumulation $plant^{-1}$ (g) as influenced by various treatments are presented in table 1.

Irrigation levels

Data in table 1 revealed that plant height, number of branches $plant^{-1}$, number of root nodules $plant^{-1}$ and dry matter accumulation $plant^{-1}$ (g) in chickpea were significantly influenced due to different levels of irrigation and was significantly more with the application of irrigation 0.6 IW/CPE ratio. Mustafa *et al.* (2008) observed that application of 0.6 IW/CPE recorded higher plant height. This is due to optimum soil moisture favouring the nutrient availability during critical growth stages intending rapid cell division and cell elongation, which inturn resulted in enhanced plant stature. Shete *et al.* (2011) found that application of irrigation recorded higher number of root nodules of chickpea. This might be owing to better nourishment provided to crop resulted in better growth due to availability of sufficient moisture. Mansur *et al*. (2010) stated that application of irrigation 0.6 IW/CPE ratio produced the highest number of branches in chickpea. Srinivasulu *et al.* (2016) revealed that increase in the dry matter accumulation in chickpea might be due to the adequate availability of moisture at all critical stages of growth and development contributing to luxurious uptake of nutrients, favourable physiological processes and active cell division with the application of irrigation which might have resulted in higher dry matter production in chickpea.

Nutrient management

Data revealed that plant height, number of branches $plant^{-1}$, root nodules $plant^{-1}$ and dry matter accumulation $plant^{-1}$ of chickpea were significantly affected due to application of nutrient treatments and were significantly maximum with the application of 100 % RDF + *Rhizobium* (Seed treatment @ 25 g kg^{-1}) + PSB (Soil application @ 5 kg ha^{-1}) but remained at par with the application of 100 % RDF + *Rhizobium* (Seed treatment @ 25 g kg^{-1}) + PSB (Seed treatment @ 25 g kg^{-1}) and 125% RDF. Mustafa *et al.* (2008) stated that the increase in plant height of chickpea due to application of nutrient treatments might be due to balanced supply of N and P through fertilizers besides the dual inoculation of *Rhizobium* and PSB induced cell division and cell elongation resulting in higher stature of plants. Harikesh *et al.* (2016) reported that application of nutrient treatments increased the number of branches $plant^{-1}$, dry matter accumulation $plant^{-1}$ due to increase in height of plant that increased nodes which induced more branches and leaves on the main shoot of plant. Root nodulation study was significantly influenced due to application of 100 % RDF + *Rhizobium* (Seed treatment @ 25 g kg^{-1}) + PSB (Soil application @ 5 kg ha^{-1}). These results are in confirmation with the findings reported by Tagore *et al.* (2013), who reported that the increase in nodulation might be due to synergistic effect of the two types of microorganisms for biological nitrogen fixation as against their individual application.

Effect on yield attributes

Data pertaining to various yield attributes studied as influenced by various treatments are presented in table 1.

Irrigation levels

Different levels of irrigation significantly influenced yield attributes of chickpea. Significantly higher number of pods $plant^{-1}$ and seed yield $plant^{-1}$ were recorded with the application of irrigation at 0.6 IW/CPE ratio over 0.8 and 1.0 IW/CPE ratio. Shete *et al*. (2011) observed that irrigation levels showed significant influence on number of pods $plant^{-1}$ and seed yield $plant^{-1}$ in chickpea. Application of irrigation to chickpea did not show any significant influence on the 100 seed weight of chickpea. However, application of irrigation 0.6 IW/CPE showed higher 100 seed weight amongst all the treatments. Shete *et al*. (2011) reported that seed yield (g) $plant^{-1}$ and straw yield $plant^{-1}$ (g) of chickpea were significantly higher with the application of 0.6 IW/CPE, this might be due to the adequate moisture supply at the critical crop growth period which resulted in better yield. Seed yield (kg ha^{-1}) and straw yield (kg ha^{-1}) of chickpea were significantly higher with the application of irrigation at 0.6 IW/CPE ratio over 0.8 and 1.0 IW/CPE ratio. This might be due to adequate moisture supply at sensitive crop growth period *i.e*. flowering and pod development for want of moisture resulted in better yield contributing characters (Shete *et al.,* 2011).

Nutrient management

Various nutrient levels significantly influenced yield attributes of chickpea. Higher number of pods $plant^{-1}$ and seed yield $plant^{-1}$ in chickpea were obtained with the application of 100 % RDF + *Rhizobium* (Seed treatment @

Table 1. Growth characters, yield and yield attributes and economics of *kabuli* chickpea as influenced by different levels of irrigation and nutrient management

Treatments	Growth characters at harvest				Yield and yield attributes							Economics		
	Plant height (cm)	No. of branches plant^{-1}	No. of root nodules plant^{-1}	Dry matter accumulation plant^{-1} (g)	No. of pods plant^{-1}	No. of seeds plant^{-1}	Test weight (gg)	Seed yield plant^{-1} (g)	Straw yield plant^{-1} (g)	Seed yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Gross Monetary returns (Rs. ha^{-1})	Net Monetary returns (Rs. ha^{-1})	B:C Ratio
Irrigation levels (I)														
I_1 - 0.6 IW/CPE ratio	45.41	11.14	8.45	34.04	44.23	51.44	28.07	10.22	22.71	1242.67	1520.27	77812	52851	3.65
I_2 - 0.8 IW/CPE ratio	44.01	10.73	7.74	32.73	43.47	50.61	27.05	9.82	21.03	1099.58	1462.78	69435	44474	3.26
I_3 - 1.0 IW/CPE ratio	43.24	9.95	6.56	31.66	42.03	46.36	26.00	9.55	19.45	876.50	1249.64	55778	30817	2.62
SE (m) ±	0.37	0.20	0.15	0.03	0.20	0.15	0.40	0.02	0.09	2.03	4.03	348.08	348.08	-
CD at 5%	1.46	0.61	0.60	0.12	0.60	0.58	-	0.08	0.33	7.96	15.81	1366.53	1366.53	-
Nutrient management (N)														
N_1 – 75% RDF + *Rhizobium* (Seed treatment @ 25 g kg^{-1}) + PSB (Soil application @ 5 kg ha^{-1})	43.68	10.25	7.20	32.31	42.52	50.04	26.53	9.76	20.16	968.11	1366.42	61530	36846	2.58
N_2 - 100 % RDF + *Rhizobium* (Seed treatment @ 25 g kg^{-1}) + PSB (Soil application @ 5 kg ha^{-1})	44.81	10.89	7.93	33.07	43.77	50.86	27.35	9.95	21.64	1119.11	1438.07	70420	45109	2.88
N_3 - 100 % RDF + *Rhizobium* (Seed treatment @ 25 g kg^{-1}) + PSB (Seed treatment @ 25 g kg^{-1})	44.17	10.59	7.56	32.92	43.12	50.35	27.11	9.86	21.20	1100.78	1417.21	69280	44389	2.89
N_4 – 125 % RDF	44.24	10.69	7.64	32.94	43.57	50.63	27.18	9.88	21.26	1103.67	1421.88	69469	44511	2.88
SE (m) ±	0.22	0.15	0.13	0.08	0.24	0.19	0.25	0.03	0.16	6.95	7.73	417.36	417.36	-
CD at 5%	0.65	0.44	0.38	0.24	0.71	0.55	-	0.10	0.46	20.65	22.96	1239.86	1239.86	-
Interaction														
SE (m) ±	0.38	0.26	0.22	0.14	0.41	0.32	0.43	0.06	0.27	12.04	13.39	722.89	722.89	-
CD at 5%	-	-	-	-	-	-	-	-	-	-	-	-	-	-

25 g kg^{-1}) + PSB (Soil application @ 5 kg ha^{-1}) but remained at par with the application of 100 % RDF + *Rhizobium* (Seed treatment @ 25 g kg^{-1}) + PSB (Seed treatment @ 25 g kg^{-1}), 125% RDF and was significantly superior over 75% RDF + *Rhizobium* (Seed treatment @ 25 g kg^{-1}) + PSB (Soil application @ 5 kg ha^{-1}). Mustafa *et al.* (2008) found that the significant increase in number of pods plant^{-1} and number of seeds plant^{-1} might be due to better translocation of photosynthates from vegetative (source) to reproductive parts (sink) resulted in higher status of yield attributes. Application of nutrient treatments to chickpea did not show any significant influence on the 100 seed weight. Seed yield plant^{-1} (g) and straw yield plant^{-1} (g) of chickpea were higher with the application of 100 % RDF + *Rhizobium* (Seed treatment @ 25 g kg^{-1}) + PSB (Soil application @ 5 kg ha^{-1}) might be due to balanced fertilizer application provided better nourishment to plant for better partitioning of dry matter and in turn results in increased seeds yield production plant^{-1} (g). Seed yield (kg ha^{-1}) of chickpea was significantly higher with the application of 100 % RDF + *Rhizobium* (Seed treatment @ 25 g kg^{-1}) + PSB (Soil application @ 5 kg ha^{-1}) as compared to all other treatments. But was found at par with 100 % RDF + *Rhizobium* (Seed treatment @ 25 g kg^{-1}) + PSB (Seed treatment @ 25 g kg^{-1}) and 125% RDF. Increase in seed yield might be attributed to the increased availability of N and P in the soil which resulted in higher growth and development and finally yields (Tagore *et al.,* 2013). The straw yield (kg ha^{-1}) of chickpea was significantly influenced due to nutrient management treatments this might be due to stimulated growth which produce photosynthetic surface and assimilation for all round development of reproductive structure and vegetative growth which ultimately enhanced the yield attributing characters (Harikesh *et al.,* 2016).

Economic studies

Data on gross monetary returns, net monetary returns and B:C ratio as influenced by various treatments are presented in table 1.

Irrigation levels

Gross monetary returns (Rs.77812 ha^{-1}) and net monetary returns (Rs.52851 ha^{-1}) were higher with the application of irrigation at 0.6 IW/CPE ratio which was significantly superior over 0.8 IW/CPE ratio and 1.0 IW/CPE ratio. Maximum B:C ratio was obtained with the application of irrigation at 0.6 IW/CPE ratio (3.65) followed by irrigation at 0.8 IW/CPE ratio (3.26) and 1.0 IW/CPE ratio (2.62). Shete *et al*. (2011) reported that the application of irrigation at 0.6 IW/CPE ratio recorded significantly higher B:C ratio.

Nutrient management

The gross monetary returns and net monetary returns were significantly influenced due to various nutrient treatments. Application of 100 % RDF + *Rhizobium* (Seed treatment @ 25 g kg^{-1}) + PSB (Soil application @ 5 kg ha^{-1}) registered significantly higher gross and net monetary returns over application of 75% RDF + *Rhizobium* (Seed treatment @ 25 g kg^{-1}) + PSB (Soil application @ 5 kg ha^{-1}) but it was found at par with the application of 100 % RDF + *Rhizobium* (Seed treatment @ 25 g kg^{-1}) + PSB (Seed treatment @ 25 g kg^{-1}) and 125% RDF. The B:C ratio was maximum with the application of 100 % RDF + *Rhizobium* (Seed treatment @ 25 g kg^{-1}) + PSB (Seed treatment @ 25 g kg^{-1}) (2.89) followed by application of 100 % RDF + *Rhizobium* (Seed treatment @ 25 g kg^{-1}) + PSB (Soil application @ 5 kg ha^{-1}) (2.88). Higher GMR and NMR were found with the application of 100 % RDF + *Rhizobium* (Seed treatment @ 25 g kg^{-1}) + PSB (Soil application @ 5 kg ha^{-1}). Gupta *et al*. (2012) reported that the optimum net return with good B:C ratio can be used for enhanced chickpea production with increased profit.

Interactions

Interactions between irrigation levels and nutrient management treatments regarding growth characters, yield and yield attributes and economics were found to be non-significant.

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