Plant Archives Vol. 17 No. 2, 2017 pp. 1319-1323 *ISSN 0972-5210*

EFFECT OF IRRIGATION AND INTEGRATED NUTRIENT MANAGEMENT ON GROWTH AND YIELD OF CHICKPEA (*CICER ARIETINUM* L.)

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Abstract

An experiment entitled "Effect of irrigation and integrated nutrient management on growth and yield of chickpea (*Cicer arietinum* L.)" was conducted at Students' Instructional Farm, Department of Agronomy, Chandra Shekhar Azad University of Agriculture & Technology Kanpur (U.P.) in *Rabi* season for two consecutive years (2014-15 and 2015-16). The soil of the experimental field was sandy loam in texture, poor in available nitrogen and organic carbon and medium in available phosphorus and potassium with slightly alkaline in reaction (pH 7.70). The experiment was conducted in Split Plot Design (SPD) with three replications and fifteen treatments combination. The main plot was consisting of three irrigation levels (no irrigation, one irrigation before flowering and one irrigation at pod development) and sub plot consisting of five nutrient management treatments (RDF-Recommended dose of fertilizer, RDF + *Rhizobium* seed inoculation, RDF + *Rhizobium* + PSB seed inoculation, 75% RDF + *Rhizobium* seed inoculation and 75% RDF + *Rhizobium* + PSB seed inoculation). Chick pea variety Avrodhi was grown with the recommended agronomic practices. The maximum growth attributes *viz*. plant height, branches/plant, dry matter/plant and yield attributes *viz*. number of pods/plant, grains/pod, grain weight/plant and 100 grain weight and grain and stover yield were observed with the application of one irrigation at pod development stage during both the years and on pooled basis. Similarly, application of 100% RDF and 100% RDF + *Rhizobium* + PSB seed inoculation remained at par in growth, yield attributes and yield of chickpea but significantly higher than rest of the treatments during both the years and on pooled basis. Application of 100% RDF and 75% RDF + *Rhizobium* + PSB seed inoculation were also remained at par in growth, yield and yield attributes of chick pea. The physico-chemical properties of soil after harvest of crop were improved by the application of inorganic fertilizers along with bio-fertilizers. Thus it may be concluded that application of one irrigation at pod development and 100% RDF or 75% RDF along with bio-fertilizers is good option for achieving higher yield and net return from chickpea crop and improving the physico-chemical properties of soil.

Key words: Irrigation, nutrient management, chickpea.

Introduction

Chickpea is the most important *rabi* pulse crop of Uttar Pradesh grown in various crop sequences under rainfed and limited irrigated conditions. Both crops in the sequence are generally fertilized with chemical fertilizers to harvest good yields. Continuous use of only chemical fertilizers impure soil health reduces crop inputs responses and is not able to sustain crop productivity. Research evidences showed that integration of biological sources of nutrients with limited chemical fertilizers may be helpful in improving soil health and sustaining the crop productivity. *Rhizobium* inoculation increases the root nodulation in chickpea and thereby more N-fixation from atmosphere (Reddy and Ahlawat, 1998). The use of PSB is considered to increase the efficiency of native as well as applied phosphorus with the secretion of organic acids (Gaur, 1990). There is an urgent need of enhancing the availability of phosphate to crop, by use of PSB cultures.

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Thus, in present investigation, integration of *Rhizobium* and PSB with chemical fertilizers was tested.

Chickpea needs 15% soil moisture by volume in the root zone (Baldev, 1988). Water-use efficiency can be improved with balanced and proper nutrition and applying irrigation at proper crop stage. Irrigation at maximum branching and pod development stages has given yield gains of 25-70%. Among these two, pod development stage was found most critical and irrigation at this stage gives higher yields (Ali and Kumar, 2005). Thus, integrated nutrient management and irrigation at proper crop stage of chickpea may increase the crop yield and improve the soil health. Keeping all above points in view, the present field investigation entitled "Effect of irrigation and integrated nutrient management on growth and yield of chickpea (*Cicer arietinum* L.)" was conducted to achieve higher yield and income from chickpea crop.

Research methodology

The research experiment was conducted at Students' Instructional Farm, Department of Agronomy, Chandra Shekhar Azad University of Agriculture & Technology Kanpur (U.P.) in *Rabi* season for two consecutive years (2014-15 and 2015-16). The soil of the experimental field was sandy loam in texture, poor in fertility in respect of available nitrogen and organic carbon and medium in respect of available phosphorus and available potassium. Soil was slightly alkaline in reaction (pH 7.70). The experiment was conducted in Split Plot Design (SPD) with three replications and fifteen treatments combination. The main plot was consisting of three irrigation levels (no irrigation, one irrigation before flowering and one irrigation at pod development) and sub plot consisting of five nutrient management treatments (RDF-Recommended dose of fertilizer, RDF + *Rhizobium* seed inoculation, RDF + *Rhizobium* + PSB seed inoculation, 75% RDF + *Rhizobium* seed inoculation and 75% RDF + *Rhizobium* + PSB seed inoculation). Chick pea variety Avrodhi was grown with the recommended agronomic practices.

Results and discussion

Effect of Irrigation

Application of one irrigation at pod development caused significant improvement in growth parameters of chickpea plant *i.e.* plant height, branches and dry-matter accumulation/plant over other treatments during both the years (table 1). Chickpea irrigated at pod development stage, on an average, attained maximum plant height of 53.50 cm, closely followed by one irrigation at before flowering (52.91cm). These two irrigation level had significantly taller chickpea plant over no irrigation of chickpea. This is probably due to adequate moisture supply during critical growth stages. Moisture during critical growth stages to the plant favourably influenced the metabolic activities in terms of higher rate of cell enlargement which directly reflected into better plant growth regarding plant height. Similar positive effect of irrigation on growth of chickpea had been reported by Bakhsh *et al*. (2007) and Thenua *et al*. (2010).

Branches and dry matter accumulation is the function of both vegetative as well as reproductive growth was favourably influenced by irrigation levels. The better growth of plant in terms of plant height and branches ultimately resulted in significantly higher dry matter accumulation under one irrigations at before flowering stage or at pod development stage (I_2 and I_3). These results confirm with the findings of Prabhakaran and Saraf (1990).

The significant increases in yield attributes *viz*., number of pods/plant, number of seeds/pod and 100-grain weight of chickpea were realized when chickpea sown with one irrigation at pod development stage and followed by one irrigation at before flowering as compared to no irrigation during both the years (table 2). Enhanced yield attributes under irrigation practices, which contributed favourable condition for plant growth by increasing the availability of nutrients to plant and enhancing the branching and leaf area for photosynthesis. These findings are on the line with those reported by Singh and Prasad *et al.* (2008).

Yield in terms of biological, grain and stover yield of chickpea influenced significantly due to irrigation levels during both the years of study. One irrigation at pod development stage produced significantly higher grain yield of chickpea than no irrigation (table 3). Under this treatment, on an average, grain, stover and biological yield of chickpea was increased to the tune of 28.94, 13.33and 19.24% compared to no irrigation level, respectively. In case of harvest index, it was not affected significantly. Harvest index of chickpea was found maximum with one irrigation at pod development stage (41.11% on pooled basis) followed by one irrigation before flowering (39.81% on pooled basis), which were also statistically superior over no irrigation during both the years. The overall development in growth and yield attributes of chickpea in association with irrigation level component crops owing to better nutritional and competition free environment led to increase in photosynthetic efficiency and translocation of photosynthates towards pod might have resulted in higher yield of chickpea These results also confirms with findings of Pramanik and Bera (2012).

Table 1: Effect of irrigation levels and nutrient management practices on growth attributes of chickpea

Treatment	Plant height (cm)			Branches/plant			Dry weight/plant (g)		
	2014-15	2015-16	Pooled	2014-15	2015-16	Pooled	2014-15	2015-16	Pooled
Irrigation level									
No irrigation	48.07	48.29	48.18	9.79	10.51	10.15	20.31	20.98	20.43
Irrigation before flowering	52.84	52.98	52.91	11.02	11.68	11.36	23.00	23.78	23.15
Irrigation at pod development	53.42	53.57	53.50	11.92	12.51	12.22	25.53	26.41	25.69
SEm±	0.10	0.13	0.12	0.10	0.06	0.08	0.04	0.08	0.02
CD at 5%	0.41	0.51	0.46	0.39	0.25	0.30	0.14	0.32	0.09
Nutrient management practices									
100% RDF	50.02	50.23	50.12	10.97	11.63	11.30	21.82	22.47	22.14
100% RDF+ *Rhizobium*	52.20	52.42	52.31	11.00	11.65	11.32	23.57	24.37	23.72
100% RDF+ *Rhizobium* + PSB	52.87	52.97	52.92	11.29	11.95	11.62	24.15	24.97	24.30
75% RDF+ *Rhizobium*	50.76	50.90	50.83	10.48	11.12	10.80	22.05	23.00	22.52
75% RDF+ *Rhizobium* + PSB	51.39	51.54	51.46	10.83	11.48	11.15	22.55	23.32	22.69
SEm±	0.16	0.23	0.19	0.07	0.07	0.07	0.11	0.10	0.11
CD at 5%	0.48	0.66	0.57	0.20	0.21	0.20	0.33	0.31	0.33
IXN	NS	NS	NS	NS	NS	NS	NS	NS	NS

Table 2: Effect of irrigation levels and nutrient management practices on yield attributes of chickpea.

Treatment	No of pods/plant			No of seeds/pod			100 seeds weight (g)		
	2014-15	2015-16	Pooled	2014-15	2015-16	Pooled	2014-15	2015-16	Pooled
Irrigation level									
No irrigation	47.31	48.16	47.73	1.33	1.37	1.35	8.31	8.37	8.34
Irrigation before flowering	52.38	53.31	52.85	1.48	1.52	1.50	9.57	9.49	9.53
Irrigation at pod development	55.25	56.23	55.74	1.56	1.60	1.58	9.89	9.76	9.82
SEm±	0.32	0.32	0.33	0.008	0.01	0.01	0.07	0.11	0.08
CD at 5%	1.27	1.28	1.27	0.03	0.04	0.04	0.29	0.42	0.33
Nutrient management practices									
100% RDF	50.97	51.87	51.42	1.46	1.51	1.48	9.39	9.20	9.30
100% RDF+ *Rhizobium*	52.08	53.01	52.55	1.49	1.53	1.51	9.52	9.55	9.54
100% RDF+ *Rhizobium* + PSB	53.77	54.62	54.25	1.54	1.58	1.56	9.91	9.74	9.83
75% RDF+ *Rhizobium*	50.47	51.37	50.92	1.33	1.37	1.35	8.28	8.36	8.32
75% RDF+ *Rhizobium* + PSB	50.95	51.86	51.41	1.44	1.49	1.46	9.19	9.17	9.18
SEm±	0.35	0.35	0.35	0.01	0.01	0.01	0.09	0.11	0.09
CD at 5%	1.03	1.05	1.04	0.03	0.03	0.03	0.27	0.32	0.28

Effect of nutrient management

Significant differences in growth parameters *viz*., plant height, Branches/plant and dry matter accumulation/ plant at successive growth stages of chickpea were observed due to integrated nutrient management practices during both the years (table 1). On an average, these growth parameters were significantly higher due to the application 100% RDF + *Rhizobium* + PSB seed inoculation over rest of the nutrient management practices. The yield attributing characters *viz*., number of pods/plant, number of seeds/pod and 100-grain weight of chickpea were significantly influenced by integrated nutrient management practices during both the years (table 2). On an average, yield components *viz*., number of pods/plant (54.25), number of seeds/pod (1.54) and 100-grain weight (9.83g) at harvest were higher due to the application 100% RDF + *Rhizobium* + PSB seed inoculation over rest of nutrient management practices

Table 3: Effect of irrigation levels and integrated nutrient management practices on yield and harvest index of chickpea.

Treatment	Grain yield (q/ha)			Stover yield (q/ha)			Biomass yield (q/ha)			Harvest Index (%)		
	2014-15	2015-16	Pooled	2014-15	2015-16	Pooled	2014-15	2015-16	Pooled	2014-15	2015-16	Pooled
Irrigation Level												
No irrigation	13.62	14.03	13.82	21.90	23.12	22.51	35.52	37.15	36.34	38.33	37.75	38.04
Irrigation before flowering	16.44	16.79	16.61	24.44	25.81	25.12	40.88	42.59	41.74	40.21	39.41	39.81
Irrigation at pod development	17.64	17.99	17.82	24.91	26.12	25.51	42.55	44.11	43.33	41.44	40.78	41.11
S Em ±	0.13	0.12	0.13	0.09	0.11	0.09	0.22	0.21	0.21	0.08	0.10	0.09
CD at 5%	0.50	0.49	0.50	0.36	0.43	0.36	0.84	0.83	0.81	0.31	0.41	0.35
Nutrient Management Practices												
100% RDF	15.85	16.22	16.03	23.94	25.21	24.58	39.79	41.42	40.61	39.72	39.04	39.38
100% RDF+ *Rhizobium*	16.20	16.58	16.39	24.27	25.57	24.92	40.47	42.16	41.32	39.95	39.26	39.60
100% RDF+ *Rhizobium* + PSB	16.96	17.36	17.16	24.94	26.02	25.48	41.91	43.38	42.64	40.39	39.96	40.17
75% RDF+ *Rhizobium*	14.96	15.31	15.14	22.48	23.69	23.09	37.45	39.00	38.22	39.88	39.18	39.53
75% RDF+ *Rhizobium* + PSB	15.52	15.88	15.70	23.12	24.59	23.86	38.64	40.47	39.56	40.05	39.14	39.59
S Em ±	0.19	0.19	0.19	0.28	0.18	0.21	0.46	0.34	0.39	0.12	0.12	0.14
CD at 5%	0.55	0.56	0.55	0.82	0.54	0.62	1.34	0.99	1.14	0.33	0.35	0.42
IXN	NS	NS	NS	NS	NS	NS	NS	NS	NS	S	NS	S

Table 4: Effect of irrigation levels and integrated nutrient management practices on economics of chickpea cultivation.

Treatments	Total cost (Rs/ha)		Gross return (Rs/ha)		Net return (Rs/ha)		B:C ratio	
	2004-15	2015-16	2004-15	2015-16	2004-15	2015-16	2004-15	2015-16
Irrigation level								
No irrigation	24132	24662	88557	87154	64425	62492	2.67	2.53
Irrigation before flowering	25343	25884	106394	103835	81051	77951	3.20	3.01
Irrigation at pod development	25343	25884	113832	110872	88489	84988	3.49	3.28
Nutrient Management Practices								
100% RDF	27349	27879	102670	100379	75321	72500	2.75	2.60
100% RDF+ *Rhizobium*	27549	28079	104888	102557	77339	74478	2.81	2.65
100% RDF+ *Rhizobium* + PSB	27749	28279	109691	107193	81942	78914	2.95	2.79
75% RDF+ *Rhizobium*	26745	27275	96876	94721	70131	67446	2.62	2.47
75% RDF+ *Rhizobium* + PSB	26845	27475	100452	98252	73607	70777	2.74	2.58

during both the years. This may be due to better synthesis of chlorophyll in leaves since bio-fertilizer contain appreciable quantities of magnesium apart from other nutrients, which might have helped in more production of photosynthates and resulted in higher values of yield attributes. These findings corroborate the results of Gawai and Pawar (2005) and Prasad *et al.* (2008).

The maximum number of pods/plant, number of seeds/pod and 100-grain weight with application of 100% RDF + Rhizobium + PSB seed inoculation ultimately resulted in higher yields (table 3). These results are in agreement with the results obtained by Singh and Sahu (2009) and Thenua *et al.* (2010) Harvest index is the function of grain yield and biological yield. Higher yield of chickpea with the application of 100% RDF + Rhizobium + PSB seed inoculation resulted into higher values of harvest index. The results are in conformity with the findings of Sahu, *et al.* (2010).

Effect on economics of chickpea cultivation

Application of one irrigation at pod development stage exhibited maximum average cost of cultivation (− 25613) and gave maximum average gross return of − 112352, net return − 86738 and benefit:cost ratio (− 3.38/rupee

invested) table 4. The higher benefits are attributed to higher yield and high market price of component crops. Among the different nutrient management practices application of 100% RDF + *Rhizobium* + PSB seed inoculation resulted in to highest average gross and net returns of − 108442 and Rs. 80428/ha, respectively, followed by 100% RDF + *Rhizobium* seed inoculation. Similarly, application of 100% RDF + *Rhizobium* + PSB seed inoculation gave maximum benefit : cost ratio. This might be due to maximum yield of chickpea under this treatment. These findings are close conformity with the results reported by Thenua *et al.* (2010).

On the basis of two year experimentation it has been found that application of 100% RDF and 100% RDF + *Rhizobium* + PSB seed inoculation remained at par in growth, yield attributes and yield of chickpea. The application of 100% RDF and 75% RDF + *Rhizobium* + PSB seed inoculation was also remained at par yield of chickpea. Thus it may be concluded that application of 100% RDF or 75% RDF along with bio-fertilizers is good option for achieving higher yield and net return from chickpea crop and improving the physico-chemical properties of soil.

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