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EFFECT OF IRRIGATION AND INTEGRATED NUTRIENT MANAGEMENT ON WATER USE EFFICIENCY AND NUTRIENT UPTAKE OF CHICKPEA (*CICER ARIETINUM* L.)

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Abstract

An experiment entitled "Effect of irrigation and integrated nutrient management on water use efficiency and nutrient uptake 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 grain yield, total consumptive use, water use efficiency and uptake of nutrients (nitrogen, phosphorus & Potassium) uptake by chickpea was noticed in plots where irrigation was applied at pod development stage during both the years. Application of 100% RDF + *Rhizobium* + PSB inoculation resulted in maximum grain yield, total consumptive use, water use efficiency and nutrients (nitrogen, phosphorus & Potassium) uptake by chickpea was noticed with the during both the years.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 grain yield, total consumptive use, water use efficiency and nutrients (nitrogen, phosphorus & Potassium) uptake by chickpea.

Key words: Water use efficiency, nutrient uptake, chickpea.

Introduction

Pulses are the major source of protein for the predominantly vegetarian society of India. In spite of various government promotional programmes, the area under pulses remained almost constant around 23 mha with marginal improvement in productivity during the last 50 years. As a result, the present production of almost 14 mt is far below the country need. 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. 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

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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. Water-use efficiency is related to fertilizers applied to the crop. Both these have synergistic relationship in general. Therefore, both aspects viz., integrated nutrient management and irrigation of chickpea crop are proposed to study in the present investigation to be conducted in central Uttar Pradesh. Keeping all above points in view, the present field investigation entitled "Effect of irrigation and integrated nutrient management on water use efficiency and nutrient uptake of chickpea (*Cicer arietinum* L.)" was conducted to achieve higher yield and water use efficiency in 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.

Result and discussion

Effect of Irrigation

The grain 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 1). Under this treatment, on an average grain yield of chickpea was increased to the tune of 28.94 compared to no irrigation level. 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).

Consumptive use of water indicates the measure of true water needs throughout the crop growth period. It indicates the water consumed by crop including a part of its utilized for growth, production and water transpired through stomatal opening besides water loss due to evaporation from the soil surface. In the present investigation the consumptive use of water recorded under I_0, I_1 and I_2 was 377.4, 388.4 and 393.4 mm during first year and 227.3, 235.3 and 241.3 mm during second year, respectively (table 1). This was clearly shows that the consumptive use of water increased with increase in the quantity of irrigation water applied. Like to consumptive use of water, the water use efficiency showed increasing trend with irrigation treatment. Water use efficiency is depends on seed yield and total water used by the crop. The maximum seed yield under the application of one irrigation at pod development stage resulted in higher values of water use efficiency. These findings are on the line with those reported by Thenua *et al.* (2010).

The nutrient uptake by chickpea crop influenced significantly due to irrigation levels during both the years of study. One irrigation at pod development stage produced significantly higher nitrogen, phosphorus and potassium uptake by chickpea than no irrigation (table 2). The nutrient uptake is the additive effect of nutrient content and seed yield which was found higher under the application of one irrigation at pod development stage and finally resulted in higher nutrient uptake.

Effect of nutrient management

The grain yield of chickpea was significantly influenced by nutrient management practices (table 1). Application of 100% RDF + Rhizobium + PSB seed inoculation recorded significantly higher grain (17.16 q/ha) of chickpea. The final yield of the crop is the cumulative effect of yield attributes and the factors which directly or indirectly influenced them. A crop can performed best only when the display of foliage on the ground surface in such a manner that utilizes maximum natural resources. Significant increase in yield components with application of 100% RDF + Rhizobium + PSB seed inoculation ultimately resulted in higher yields. These results are in agreement with the results obtained by Sahu *et al.* (2008), Singh and Sahu (2009), Thenua *et al.* (2010) reported that with the application of RDF along with

Table 1: Effect of irrigation levels and integrated nutrient management practices on yield and water use efficiency of chickpea.

Treatment	Grain yield (q/ha)			Total water use (mm)		WUE (kg seed/ha mm of water)	
	2014-15	2015-16	Pooled	2014-15	2015-16	2014-15	2015-16
Irrigation level							
No irrigation	13.62	14.03	13.82	377.4	227.3	3.61	6.17
Irrigation before flowering	16.44	16.79	16.61	388.4	235.3	4.23	7.14
Irrigation at pod development	17.64	17.99	17.82	393.4	241.3	4.48	7.46
S Em ±	0.13	0.12	0.13	-	-	-	-
CD at 5%	0.50	0.49	0.50	-	-	-	-
Nutrient Management Practices							
100% RDF	15.85	16.22	16.03	378.4	226.7	4.19	7.15
100% RDF+ *Rhizobium*	16.20	16.58	16.39	381.4	231.7	4.25	7.16
100% RDF+ *Rhizobium* + PSB	16.96	17.36	17.16	386.4	240.2	4.39	7.23
75% RDF+ *Rhizobium*	14.96	15.31	15.14	378.4	226.2	3.95	6.77
75% RDF+ *Rhizobium* + PSB	15.52	15.88	15.70	377.9	229.7	4.11	6.91
S Em ±	0.19	0.19	0.19	-	-	-	-
CD at 5%	0.55	0.56	0.55	-	-	-	-

Table 2: Effect of irrigation levels and integrated nutrient management practices on nutrient uptake by chickpea crop.

Treatment	Nitrogen uptake (kg/ha)			Phosphorus uptake (kg/ha)			Potash uptake (kg/ha)		
	2014-15	2015-16	Pooled	2014-15	2015-16	Pooled	2014-15	2015-16	Pooled
Irrigation level									
No irrigation	105.58	110.54	108.06	29.78	31.42	30.60	45.06	47.67	46.37
Irrigation before flowering	128.19	133.82	131.00	36.48	38.26	37.37	53.31	56.80	55.06
Irrigation at pod development	139.43	145.24	142.33	39.93	41.73	40.83	56.96	60.84	58.90
S Em ±	1.62	1.76	1.69	0.45	0.41	0.43	0.56	0.98	0.71
CD at 5%	6.34	6.86	6.59	1.77	1.60	1.68	2.20	3.82	2.79
Nutrient Management Practices									
100% RDF	125.30	130.29	127.80	36.08	37.84	39.96	51.47	54.76	53.11
100% RDF+ *Rhizobium*	129.83	135.71	132.77	37.98	39.87	38.92	56.37	60.09	58.22
100% RDF+ *Rhizobium* + PSB	138.10	143.84	140.97	40.38	42.26	41.32	59.33	62.65	60.99
75% RDF+ *Rhizobium*	108.83	114.09	111.46	27.84	29.21	28.52	42.51	45.25	43.88
75% RDF+ *Rhizobium* + PSB	119.93	125.40	122.66	34.70	36.52	35.61	49.21	52.77	50.99
S Em ±	1.97	1.45	1.68	0.55	0.49	0.51	0.78	0.58	0.66
CD at 5%	5.76	4.23	4.91	1.60	1.43	1.50	2.28	1.71	1.93

biofertilizer improves the grain yield of chickpea.

The highest consumptive use of water and water use efficiency was found with the application of 100% RDF + *Rhizobium* + PSB inoculation than rest of the treatments during both the years. This might be due to better availability of nutrients in this treatment improves the root development and growth of crop which utilizes more water from the soil.

Significant differences in nutrient uptake by chickpea were observed due to various nutrient management practices during both the years (Table 2). The significantly higher amount of NPK uptake by chickpea crop was recorded with the application 100% RDF + *Rhizobium* + PSB seed inoculation as inorganic and organic fertilization over other nutrient management practices during both year. More uptake of nutrient by 100% RDF + *Rhizobium* + PSB seed inoculation was attributed to proportionate increase in dry matter production and increase in grain yield, which ultimately increased the total uptake of nutrients. Similarly, more nutrient uptake by nutrient management practice of 100% RDF + *Rhizobium* + PSB seed inoculation might be increased nutrient availability, influences rhizosphere bacteria and microorganisms to increase mineral nutrition of plants by changing root-uptake characteristics, modification of root morphology or alteration of uptake mechanism, relative growth rate or internal composition of chickpea plant. Gangwar and Dubey (2012) also reported increased in nutrient uptake by chickpea crop with the application of bio-fertilizers.

On the basis of two year experimentation it has been found that application of 100% RDF + *Rhizobium* + PSB seed inoculation and one irrigation at pod development stage resulted in maximum grain yield, water use efficiency and nutrient (nitrogen, phosphorus and potassium) uptake by chickpea crop. Application of 100% RDF+ *Rhizobium* + PSB and 75% RDF+ *Rhizobium* + PSB resulted in almost similar results. Thus it may be concluded that application of 100% RDF or 75% RDF along with bio-fertilizers is good option for achieving higher yield, water use efficiency and nutrient uptake by chickpea crop.

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