



## Effect of integrated nutrient management and drought mitigating practices on performance of rainfed chickpea (*Cicer arietinum*)

SAVITA DEWANGAN<sup>1</sup>, RAJENDRA PRASAD SINGH<sup>2</sup>, M K SINGH<sup>3</sup> and SMITA SINGH<sup>4</sup>

*Institute of Agricultural Sciences, BHU, Varanasi, Uttar Pradesh 221 005*

Received: 10 March 2016; Accepted: 15 September 2016

### ABSTRACT

The investigation aimed to study the effect of integrated nutrient management and drought mitigating practices on rainfed chickpea (*Cicer arietinum* L.) on sandy clay loam soil at Varanasi in winters of 2012-13 and 2013-14. The treatment consisted of combinations of four integrated nutrients levels in main plot and five drought mitigating practices including control in sub-plot. The growth and yield were significantly influenced by different integrated nutrients during both the years. Application of 100% RDF + 2% urea spray proved significantly superior to the 100% RDF + 25% N (VC), 100% RDF + 5 kg Zn/ha and 100% RDF in terms of growth and yield attributes, net returns and B:C ratio. Foliar spray of 2% KCl + 0.4% sodium selenite recorded maximum values of growth and yield of chickpea which was found comparable with 2% KCl during both the years. The maximum net return (₹ 23 880) and B:C ratio (1.97) was recorded under 2% KCl during both the years. It is concluded that significant improvement in growth characters, yield attributes, yields and nutrients uptake were recorded with the application of 100% RDF + 2% urea spray during both the years of experimentations. Similarly, among the drought mitigating practices, application of 2% KCl + 0.4% Sodium selenite spray was found significantly superior to others during both the years of experiment. 100% RDF + 2% Urea spray resulted in maximum gross return, net return and B:C ratio during both the years of study. Among the drought mitigating practices, application of 2% KCl + 0.4% Sodium selenite spray showed maximum gross return during both the year while maximum net return as well as B:C ratio were associated with 2% KCl spray during both the year of investigation.

**Key words:** Chickpea, Drought mitigating practices, Economics, Integrated nutrient management, Nutrient uptake and Nodulation, yield

Chickpea (*Cicer arietinum* L.) is the most important winter season (*rabi*) grain legume in India, grown predominantly under rainfed conditions on residual moisture after harvest of *kharif* crops. Lack of adequate soil moisture in the seedbed is a major hindrance to the establishment of chickpea crop. This is because inadequate soil moisture can reduce seed germination, slow down seedling growth and diminish yield in rainfed crops (Sharma 1985). Pre-sowing irrigation or protective irrigation at critical stage of crop growth improves its productivity. of crop. About 90% of world's chickpea is grown under rain-fed conditions and experiences terminal drought stress resulting in heavy yield losses. Therefore, it needs to find solutions to mitigate these drought effects by applying various drought mitigating practices. The low yield of chickpea is not only due to its cultivation

on sub-marginal lands and moisture stress but also due to poor levels of nutrient management. To maintain soil quality and nutritional quality on a sustainable basis for the increasing population a judicious combination of both (fertilizer and organic manures) is most desirable, provided other agronomic practices are optimized (Sankaram 1996). Keeping these in view, the present investigation was carried out to find out the effect of integrated nutrients and drought mitigating practices on performance of rainfed chickpea.

### MATERIALS AND METHODS

A field experiment was conducted during winters of 2012-13 and 2013-14 at the Research Farm, Institute of Agricultural Sciences, BHU, Varanasi in sandy clay loam soil. The rainfall received during the growing period of crop was 76.4 mm in 2012-13 and 138.3 mm in 2013-14. The experimental soil was poor in organic carbon (0.35%), available nitrogen (193.60 kg) and sulphur (19.8 kg) and medium in available phosphorus (19.80) and available potassium (212.30 kg). Zinc was below the critical limit (0.53 ppm). The experiment was laid-out in a split plot design with three replications. Four integrated nutrients, viz. 100 % RDF(M<sub>1</sub>), 100% RDF + 2% Urea spray (M<sub>2</sub>),

<sup>1</sup>Research Scholar (e mail: savita87bhu@hotmail.co.in),  
<sup>2</sup>Professor (e mail: singhrpd77@gmail.com), <sup>3</sup>Asst. Professor (e mail: manozsingh@rediffmail.com), Department of Agronomy, Institute of Agricultural Sciences, BHU, Varanasi 221 005.  
<sup>4</sup>Technical Assistant (e mail: sapnapuat@gmail.com), Department of Agronomy, College of Agriculture, Rewa 486 001

100% RDF + 25% RDN (VC) ( $M_3$ ) and 100% RDF + 5kg Zn/ha ( $M_4$ ) were allocated to main plot where RDF represents recommended dose of N, P, K and S (20-40-20-20 kg/ha) through inorganic fertilizers and RDN represents recommended dose of nitrogen through vermicompost. Five drought mitigating practices, viz. control ( $S_1$ ), water spray ( $S_2$ ), 2% KCl spray ( $S_3$ ), 0.4% sodium selenite spray ( $S_4$ ) and 2% KCl + 0.4% sodium selenite ( $S_5$ ) applied twice at pre-flowering and pod formation stage were allocated to subplot. The gross and net plot size were 22.5 m<sup>2</sup> (5.0 × 4.5 m<sup>2</sup>) and 10.8 m<sup>2</sup> (4.0 × 2.7 m<sup>2</sup>), respectively.

Nitrogen, phosphorus, potassium, sulphur and zinc fertilizers were applied just before sowing according to the treatment using urea, DAP, murate of potash, gypsum and zinc oxide. Fertilizers were applied in band 4-5 cm below the surface. The required amount of RDN (vermicompost) containing N (3.0%), P (1.0%) and K (1.5%) as per the treatment were incorporated in the plots after preparing the layout as per treatment in to the soil during both the years. The chickpea cultivar Avarodhi was sown on November 11 and 12, respectively, during 2012 and 2013. Crop seeds was sown @ 80 kg/ha with the help of spade (*kudal*). The optimum plant population was maintained by thinning and gap filling (within 10-12 days after sowing) to ensure the uniform plant population. The other cultural operations were done as per recommendation and crop requirement. The observations on growth parameters such as plant height, branches/plant, dry matter production/plant and root dry matter production/plant were recorded at 30, 60, 90 DAS and at harvest stage while number of nodules were recorded at 40 and 60 days after sowing. The roots were cut at shoot-root demarcation and were air-dried first and later oven dried for a period of 12 hrs until a constant weight was recorded for root dry matter/plant. Five randomly selected plants from each plot were uprooted carefully by digging around the plants. The soil was washed-off by dipping root portions in standstill water. Then, total number of nodules per plant were counted. The observations on yield were recorded at physiological maturity. The nutrient uptake in chickpea were estimated as N (Colorimetric method), P (Vanado molybdate yellow colour method), K (Flame-Photometric method), S (Turbidimetric method) and Zn (Atomic absorption spectrophotometry). The benefit cost ratio was workout based on the present market price of crops and chemicals.

## RESULTS AND DISCUSSION

### Effect on growth and yield of chickpea

Integrated nutrients markedly increased

Table 1 Growth and yield parameters of chickpea as influenced by integrated nutrients and drought mitigating practices

Treatments	Plant height (cm)		Branches/plant		Dry matter/plant (g)		Root dry matter/plant		Number of nodules/plant at 40 DAS		Number of nodules/plant at 60 DAS	
	2012-13	2013-14	2012-13	2013-14	2012-13	2013-14	2012-13	2013-14	2012-13	2013-14	2012-13	2013-14
<i>Integrated nutrient management</i>												
$M_1$	53.16	52.22	20.62	19.94	14.21	7.86	1.78	1.19	10.00	10.26	13.16	13.25
$M_2$	58.61	54.36	23.09	21.93	19.38	10.96	2.32	1.78	13.33	11.43	17.87	14.94
$M_3$	56.44	54.25	22.93	21.18	18.86	10.83	2.13	1.74	12.47	11.41	17.39	14.57
$M_4$	54.58	52.75	21.18	20.60	16.11	8.71	2.01	1.47	12.42	11.40	16.02	14.12
SEm±	0.97	0.12	0.22	0.29	0.17	0.04	0.02	0.01	0.26	0.02	0.33	0.05
C D (P=0.05)	3.34	0.43	0.76	1.00	0.58	0.14	0.01	0.05	0.91	0.07	1.15	0.16
<i>Drought mitigating practices</i>												
$S_1$	54.47	52.26	19.90	18.98	16.22	9.16	1.95	1.34	11.37	10.38	15.14	13.23
$S_2$	55.48	52.64	20.98	19.97	16.60	9.40	2.02	1.43	11.84	10.82	16.08	13.73
$S_3$	56.23	53.99	22.74	21.61	17.51	9.75	2.12	1.65	12.30	11.45	16.24	14.67
$S_4$	55.90	53.95	22.15	20.88	17.12	9.60	2.06	1.54	12.08	11.13	16.19	14.18
$S_5$	56.39	54.15	24.00	23.13	18.25	10.04	2.16	1.77	12.69	11.85	16.90	15.29
SEm±	0.43	0.13	0.23	0.21	0.15	0.05	0.01	0.02	0.24	0.03	0.37	0.04
C D (P=0.05)	1.23	0.37	0.67	0.62	0.42	0.16	0.03	0.04	0.68	0.08	1.07	0.10

various growth parameter, viz. plant height, number of branches per plant, dry matter production per plant, root dry matter production per plant, number of nodules per plant and nodules dry weight per plant of chickpea during both the years. Application of 100% RDF + 2% urea spray proved significantly superior to rest of the treatments in respect of plant height, number of branches per plant, dry matter production per plant and root dry matter production per plant at all the growth stages of chickpea (except 30 DAS) during both the years. However, this treatment was on a par with 100% RDF + 25% N(VC) with respect to plant height, number of branches/plant, number of nodules/plant and nodules dry weight/plant. This might be due to increased photosynthetic activity, efficient translocation and utilization of photosynthates causing rapid cell elongation and cell division at growing region of the plant leading to stimulation of growth, besides increasing uptake of nutrients (Dicks 1980). Also, supply of all the essential mineral nutrients in a balanced proportion and amount which resulted in better growth and development of plants (Kene 1990). Among drought mitigating practices, foliar spray of 2% KCl + 0.4% Sodium selenite was found at par to 2% KCl spray in respect of plant height and significantly superior to rest of the treatments for other growth attributes (number of branches per plant, dry matter production/plant and root dry matter production/plant, number of nodules/plant and nodules dry weight/plant) during both the years of experimentation (Table 1). This might be due to increased application of K which might have to enhance photosynthetic rate, plant growth, yield, and drought resistance in different crops under water stress condition (Egilla *et al.* 2005, Pervez *et al.* 2004). These results are in conformity with the findings of Seppanen *et al.* (2003).

Application of 100% RDF + 2% urea spray recorded significantly higher seed (1348 and 1051 kg/ha) and stover (3260 and 2636 kg/ha) yields, respectively. It was closely followed by 100% RDF + 25% N(VC) and proved significantly superior to rest of the treatments (Table 2). The highest harvest index (28.50 and 28.88%) was found under 100% RDF + 2% urea spray and significantly superior to 100% RDF + 25% N(VC), 100% RDF + 5 kg Zn/ha and 100% RDF during both the years of study. This envisages a direct role of nitrogen to seed growth and a guided help in minimizing osmotic imbalance present during final stage in seed filling (Kachot *et al.* 2001). These results are in close conformity with Rajkhowa (2002). Among drought mitigating practices, foliar spray of 2% KCl + 0.4% Sodium selenite recorded highest seed yield, stover yield and harvest index and significantly superior to rest of the treatments during both the years of investigation. This might be due to the fact that the plant growth promoted by Se is due to the increased starch accumulation in chloroplasts and

Table 2 Yield and economics of chickpea as influenced by integrated nutrients and drought mitigating practices

Treatment	Seed yield (kg/ha)		Stover yield (kg/ha)		Harvest index (%)		Net returns (₹/ha)		B:C ratio	
	2012-13	2013-14	2012-13	2013-14	2012-13	2013-14	2012-13	2013-14	2012-13	2013-14
<i>Integrated nutrient management</i>										
M1	1083	799	2729	2018	28.41	27.72	22329	10064	1.92	1.42
M2	1348	1051	3260	2636	29.25	28.50	32496	19818	2.29	1.79
M3	1319	1008	3223	2551	29.05	28.31	29722	16410	2.11	1.61
M4	1223	828	3018	2154	28.84	27.78	26377	9494	2.01	1.36
SEM±	9.12	13.84	20.76	38.85	0.04	0.05	389.90	602.20	0.02	0.03
C D (P=0.05)	31.57	47.91	71.85	134.45	0.15	0.16	1349.23	2083.89	0.06	0.09
<i>Drought mitigating practices</i>										
S1	1170	832	2898	2147	28.73	27.57	27243	12816	2.17	1.55
S2	1206	883	2973	2268	28.84	27.86	27895	14108	2.16	1.59
S3	1278	969	3133	2438	28.96	28.30	30498	17262	2.24	1.70
S4	1243	925	3066	2358	28.83	28.03	25106	11500	1.88	1.40
S5	1321	997	3217	2486	29.09	28.63	27913	14046	1.96	1.48
SEM±	9.00	8.11	21.16	20.22	0.05	0.04	385.26	349.17	0.02	0.01
C D (P=0.05)	25.92	23.35	60.96	58.23	0.13	0.10	1109.81	1005.83	0.05	0.04
Pooled										

potassium is also involved in photophosphorylation, transportation of photoassimilates from source tissues (Pettigrew 2008, Pennanen and Hartikainen 2002).

#### Effect on economics

Pooled data in Table 2 showed that maximum net returns of ₹ 26 157/ha was obtained with 100% RDF + 2% Urea spray followed by 100% RDF + 25% RDN (VC). However, the lowest net return (₹16 197) was recorded with 100% RDF during both the years of study. Application of 100% RDF + 2% urea spray recorded maximum B:C ratio of 2.04 and was significantly superior to other treatments. The results are in close conformity with the findings of Gupta *et al.* (2015). Among various drought mitigating practices, application of 2% KCl spray resulted into maximum net return of ₹ 23 880 and B:C ratio of 1.97 and proved significantly superior to rest of the practices. The findings are in consonance with that of Nandan *et al.* (1998).

#### Effect on nutrient uptake

Integrated nutrient management significantly improved the total uptake of N, P, K, S, and Zn in chickpea. Application of 100% RDF + 2% urea spray [N (77.88, 64.75), P (15.14, 10.30), K (30.51, 22.46), S (14.90, 9.98) and Zn (53.83, 55.55)] was found comparable with 100% RDF + 25% N(VC) and proved significantly superior to 100% RDF + 5 kg Zn/ha and 100% RDF [N (54.63, 40.39), P (9.37, 5.65), K (21.06, 13.43), S (9.81, 5.45) and Zn (33.64, 35.45)] in respect of total nitrogen, phosphorus, potassium, sulphur and zinc uptake of chickpea. However, maximum zinc content was associated with 100% RDF + 5 kg Zn/ha [grain (20.39, 25.74 mg/kg of seed) and straw (8.72, 12.54 mg/kg of seed)]. This was mainly due to higher biological production and developed root system with enhanced root activity (Kene *et al.* 1990, Vasanthi and Subramaniam 2004).

Foliar spray of 2% KCl + 0.4% sodium selenite [N (76.75, 60.78), P (14.49, 9.71), K (28.48, 21.34), S (15.12, 9.56) and Zn (56.83, 55.57)] was significantly superior to rest of the treatments. The second best treatment in order of magnitude was 2% KCl which proved significantly superior to rest of the three treatments in respect of total uptake of N, P, K, S, and Zn in chickpea. This might be due to increased grain and stover yields and increased N, P, K, S, and Zn contents in grain and stover (Pennanen and Hartikainen 2002).

Hence, it is concluded that significant improvement in growth characters, yield attributes, yields and nutrients uptake were recorded with the application of 100% RDF + 2% urea spray during both the years of experimentations. Similarly, among the drought mitigating practices, application of 2% KCl + 0.4% sodium selenite spray was found significantly superior

Table 3 Nutrient uptake of chickpea as influenced by integrated nutrients and drought mitigating practices

Treatment	Total N uptake (kg/ha)		Total P uptake (kg/ha)		Total K uptake (kg/ha)		Total S uptake (kg/ha)		Total Zn uptake (g/ha)	
	2012-13	2013-14	2012-13	2013-14	2012-13	2013-14	2012-13	2013-14	2012-13	2013-14
<i>Integrated nutrient management</i>										
M <sub>1</sub>	54.63	40.39	9.37	5.65	21.06	13.43	9.81	5.45	33.64	35.45
M <sub>2</sub>	77.88	64.75	15.14	10.30	30.51	22.46	14.90	9.98	53.83	55.55
M <sub>3</sub>	74.60	60.02	13.92	9.21	27.50	20.27	13.83	8.73	49.27	52.74
M <sub>4</sub>	67.15	47.61	11.83	6.98	23.70	15.72	11.98	7.16	51.37	48.58
SEm ±	2.02	1.02	0.21	0.11	0.43	0.25	0.16	0.12	0.78	0.51
C D (P=0.05)	6.99	3.54	0.72	0.38	1.48	0.88	0.56	0.43	2.69	1.75
<i>Drought mitigating practices</i>										
S <sub>1</sub>	60.43	44.54	10.59	6.12	22.54	14.44	10.39	6.40	38.50	39.65
S <sub>2</sub>	64.79	49.68	11.35	7.23	24.00	16.40	11.65	7.25	42.29	44.48
S <sub>3</sub>	72.10	57.62	13.36	8.98	27.27	19.66	13.56	8.43	50.74	51.70
S <sub>4</sub>	68.77	53.34	13.03	8.11	26.17	18.02	12.42	7.50	46.77	48.99
S <sub>5</sub>	76.75	60.78	14.49	9.71	28.48	21.34	15.12	9.56	56.83	55.57
SEm±	0.93	0.55	0.27	0.09	0.63	0.19	0.14	0.11	0.67	0.55
C D (P=0.05)	2.69	1.57	0.77	0.26	1.82	0.54	0.42	0.32	1.94	1.58

to others during both the years of experiment. Application of 100% RDF + 2% Urea spray resulted in maximum gross return, net return and B:C ratio during both the years of study. Among the drought mitigating practices, application of 2% KCl + 0.4% Sodium selenite spray showed maximum gross return during both the year while maximum net return as well as B:C ratio were associated with 2% KCl spray during both the year of investigation.

#### ACKNOWLEDGEMENT

The authors would like to thank Department of Science and Technology (DST), New Delhi, Government of India, for their financial support to conduct this study through INSPIRE programme.

#### REFERENCES

- Dicks J W. 1980. Mode of action of growth retardants. (*In*) *Research Development on the use of Plant Growth Retardants*, pp 1–14. Clifford D R and Lenton J R (Eds). Monograph 4 British Plant Growth Regulator Group.
- Egilla JN, Davies F T J and Boutton T W. 2005. Drought stress influences leaf water content, photosynthesis, and water-use efficiency of *Hibiscus rosa-sinensis* at three potassium concentrations. *Photosynthetica*. **43**:135–40.
- Gupta K C and Saxena R. 2015. Resource management in cowpea (*Vigna unguiculata* L. Walp.). *Journal of Crop and Weed* **11** (Special Issue): 146–8.
- Kachot N A, Malvia D D, Solanki R M and Sagarka B K 2001. Integrated nutrient management in rainy season ground nut (*Arachis hypogea*). *Indian Journal of Agronomy*. **46** (3): 516–22.
- Kene D R, Sirsat M T, Thakare K K and Darange O G. 1990. Response of pigeonpea to higher level of fertilization and its effect on nodulation and nitrogen fixation. *PKV Research Journal*. **14**: 182–5.
- Nandan R, Sharma H M, Singh R N P and Nandan R. 1998. Response of late sown chickpea to irrigation and foliar nutrition in calcareous soil. *Journal of Applied Biology and Biotechnology*. **8**: 5–8.
- Pennanen A, Xue T and Hartikainen H. 2002. Protective role of selenium in plant subjected to severe UV irradiation stress. *Journal of Applied Botany and Food Quality*. **76**: 66–76.
- Pervez H, Ashram M and Makhdam M I. 2004. Influence of potassium nutrition on gas exchange characteristics and water relations in cotton (*Gossypium hirsutum* L.). *Photosynthetica*. **42**: 251–5.
- Pettigrew W T. 2008. Potassium influences on yield and quality production for maize, wheat, soybean and cotton. *Physiologia Plantarum* **133**: 670–81.
- Rajkhowa D J, Saikia M and Rajkhowa K M. 2002. Effect of vermicompost with and without fertilization of greengram. *Legume Research* **25** (4): 295–6.
- Sankaram A. 1996. Soil fertility management for reconciling sustainability with productivity. *Journal of the Indian Society of Soil Science* **44** (4): 593–600.
- Seppanen M, Turakianen M and Hartikainen H. 2003. The effect of selenium on photoxidative stress tolerance in potato. *Plant Science*. **165**: 311–9.
- Sharma K K. 2004–2005. Development and Evaluation of Transgenic Chickpea for Tolerance to Drought and Low Temperature Stress Using P5 CFS Gene and Drought Responsive Regulatory Elements. Program Report, Patancheru. *International Crops Research Institute for the Semi-Arid Tropics*, Andhra Pradesh, India.
- Sharma R A. 1985. Influence of drought stress on the emergence and growth of chickpea seedlings. *International Chickpea Newsletter* **12**: 15–6.
- Vasanthi D and Subramanian S. 2004. Effect of vermicompost on nutrient uptake and protein content in blackgram. *Legume Research*. **27** (4): 293–5.