E-ISSN: 2618-0618
P-ISSN: 2618-060X

www.agronomyjournals.com
2024; 7(1): 432-435
Received: 04-11-2023
Accepted: 10-12-2023

Manoj Kumar
Rani Lakshmi Bai Central Agricultural University, Jhansi, Uttar Pradesh, India

SS Singh
Rani Lakshmi Bai Central Agricultural University, Jhansi, Uttar Pradesh, India

Yogeshwar Singh
Rani Lakshmi Bai Central Agricultural University, Jhansi, Uttar Pradesh, India

Chaitanya Prasad Nath
ICAR-Indian Institute of Pulse Research, Kanpur, Uttar Pradesh, India

DR Palsaniya
Rani Lakshmi Bai Central Agricultural University, Jhansi, Uttar Pradesh, India

Mahendra Prasad
Rani Lakshmi Bai Central Agricultural University, Jhansi, Uttar Pradesh, India

Narendra Kumar Bhinda
Rani Lakshmi Bai Central Agricultural University, Jhansi, Uttar Pradesh, India

Prakash Chand Choudhary
Rani Lakshmi Bai Central Agricultural University, Jhansi, Uttar Pradesh, India

Corresponding Author:
Chaitanya Prasad Nath
ICAR-Indian Institute of Pulse Research, Kanpur, Uttar Pradesh, India

Effect of tillage and bioregulators on physiological parameters and yield of rainfed chickpea (*Cicer arietinum* L.)

Manoj Kumar, SS Singh, Yogeshwar Singh, Chaitanya Prasad Nath, DR Palsaniya, Mahendra Prasad, Narendra Kumar Bhinda and Prakash Chand Choudhary

DOI: https://doi.org/10.33545/2618060X.2024.v7.i1f.258

Abstract
This study was carried out to evaluate the "Effect of tillage and bioregulators on physiological parameters and yield of rainfed chickpea (*Cicer arietinum* L.)" at Rani Lakshmi Bai Central Agricultural University, Jhansi, UP, during *Rabi* season of 2020-21 in loamy soil. The experimentation was laid out in Split Plot Design with three levels of tillage treatments in main plots *viz*, CT, ZT and ZT+R. and five levels of bioregulators in sub-plot applied at flower initiation and pod filling stage. Among tillage practices ZT+R was found superior over ZT and CT treatment with respect CGR, grain yield and relative water content (RWC). Relative growth rate (mg/g/day) did not change significantly among tillage and bioregulators. Canopy temperature of plant significantly reduced under ZT+R treatment at 125 and 135 DAS over CT and ZT treatment. Foliar application of thiourea (1000 ppm) significantly reduced plant canopy temperature at 125 and 135 DAS. Foliar application of salicylic acid (50 ppm) treatment significantly increased the relative water content, grain yield and crop growth rate in chickpea over control. Interaction effect showed that KNO_3 (2%) had significantly highest grains yield (12.5 q/ha) in ZT+R treatment as compared to ZT and CT treatment.

Keywords: Tillage and bioregulators, physiological parameters, rainfed chickpea, *Cicer arietinum* L.

Introduction
Chickpea is mostly grown in rainfed areas and marginal soils of India. Average chickpea productivity falls below the potential yield of the available cultivars. Chickpea productivity is low in rainfed sites due to a variety of abiotic challenges (salt, drought, high temperature, cold and heavy metal stresses). Climate change is the most key constraint to chickpea production since drought affects about half of the geographical area on the world. Drought stress lowers chickpea output by 45–50 percent across the world (Ahmad *et al*., 2005; Thudi *et al*., 2014) [1, 10]. With the availability of bio-regulators a new window has been opened for enhancing the crop yields under stress conditions. Bio-regulators have a pivotal role in canopy temperature crop, growth, development and source to sink relationship to enhance the crop yield (Pandey *et al.,* 2013) [6]. Alongside combating the stresses by bioregulators coupling these bio-regulators with resource conserving technologies like zero-tillage, residue under zero tillage helps in conserving the scarce resources and resource-use efficiency. Thus, the main objective of the present study was to find out the Effect of tillage and bioregulators on physiological parameters and yield of rainfed chickpea (*Cicer arietinum* L.)

Materials and Methods
The field experiment was conducted in *Rabi* season 2020-21 under rainfed condition at Rani Lakshmi Bai Central Agricultural University, Jhansi, Uttar Pradesh, India. The experimental site is located in Bundelkhand region of Uttar Pradesh at 25°31'07.1" N latitude and longitude of 78°33'47.4 E with 284 meters above from mean sea level (MSL). The experiment was laid out in split plot design in which three levels of tillage namely conventional tillage, zero tillage, and zero tillage with crop residue retention (5t/ha) was allotted to the main plot and five different bioregulators namely control or water spray, salicylic acid (50 ppm), Potassium nitrate (2%), Thiourea (1000 ppm), and Potassium + Multi-micronutrient complex (1%)

allotted to sub plots. Bioregulators applied as foliar spray at flower initiation and pod filling stage. Seed rate of crop (RVG-202) was 60 kg/ha and recommended dose of nutrients 20 kg nitrogen, 50 kg phosphorus/ha and 20 kg/ha potassium applied as basal dose.

The cumulative total pan evaporation was 88.1 mm during the entire growing season. During this time, the average maximum and lowest temperatures were 27.86 °C and 10.86 °C, respectively. The highest relative humidity was 78-90 percent, while the minimum was 33-65 percent. The average wind speed reported between 2.4 and 4.2 km/hr. The crop received 2.0, 1.0, 3.8, 4.6 and 4.2 mm precipitation in 47th, 6th, 7th, 11th and 12th meteorological weeks, respectively. However 15.6 mm of total rainfall received by chickpea thought the growing season. All the procedures, equations and methods were used during research programme regarding data collection and interpretation are given below:

Crop growth rate: Crop growth per unit area was calculated and expressed as gram per meter squared per day at 0-30, 30-60, and 60-90 days after sowing.

$$\mathrm{CGR} = \frac{1}{\mathrm{p}} * \frac{\mathrm{W2} - \mathrm{W1}}{\mathrm{T2} - \mathrm{T1}}$$

P = Land area, W_1= Dry matter at T_1 time and W_2= Dry matter at T_2 time

Relative growth rate: The rate of growth per unit dry matter was calculated at 30-60 and 60-90 days after sowing and expressed as g/g/day, which means one gram of dry matter produced by one gram of existing dry matter per day.

$$RGR = \frac{(\log_e w_2 - \log_e w_2)}{(t_2 - t_1)}$$

W_1= Dry matter at T_1 time and W_2= Dry matter at T_2 time

Seed yield: The seed yield was obtained from net plot area in kg and later it was converted into tonnes per hectare.

Relative water content: was measure with fully expanded leaf which was picked from top to just below of the parts and measured fresh weight, for turgid weight leaves were soaked in water for 4 hours at room temperature and dry weight leaves were dried at 84 °C for 3 days. The values of FW, TW, and DW were obtained from leaves and RWC was measured by Turner equation (1981) [11].

$$\mathrm{RWC}(\%) = \frac{(\mathrm{FW} - \mathrm{DW})}{(\mathrm{TW} - \mathrm{DW})} \times 100$$

Whereas
FW: Fresh weight
DW: Dry weight
TW: Turgid weight

Canopy temperature: The surface temperature of the crop canopy was measured by an infrared thermometer (°C) after pod filling till physiological maturity at 10 days interval.

Statistical Analysis: On the basis of observed data on growth stages quality, soil parameters yield attributes and final yield were statistically examined by standard analysis of variance table for split plot design Gomez and Gomez, (1984) [2]. On the basis of least significant difference the significant difference were estimated at 5% level of significance.

Results and Discussions

Growth rates: Perusal of analyzed data (Table 1.) reveals that among main plots treatments there were no significant difference observed at 0-30DAS and 30-60 DAS with respect to CGR. It might be due to there was not significant moisture reduction from conventional tillage plots in initial some days and provided almost similar favorable soil condition like as other tillage treatments for plant growth and development, however at 60-90 DAS ZT+R treatment established significantly higher crop growth rate over ZT and CT treatments. Kumar (2016) [4] observed that Mulching practices significantly increased total dry matter production over no-mulch and subsequently increases crop growth rate in moisture stress period as compared to without mulch. Likewise foliar application of salicylic acid (50 ppm) recorded significantly higher crop growth rate at 60 to 90 DAS over Thiourea (1000 ppm), K+ Multimicronutrient (1%) and control (water spray) and at par with KNO_3. It may be due to salicylic acid improved assimilate partitioning, photosynthetic efficiency and boost the source to sink relationship which leads to improved crop growth rate of plant. Similarly foliar application of KNO_3 provided potassium and nitrogen, potassium governs stomata regulation and maintained water balance in plant. Potassium is also constituent of more than 60 enzymes which regulate the physiology of plant and on other side nitrogen increases the dry matter accumulation in plant and may be subsequently increased the crop growth rate. Since Relative growth rate is the based on per unit dry matter accumulation from per unit existing dry matter, statistically analyzed data (Table 1.) showed that there was no significant difference in relative growth rate (mg/g/day) at 30-60 and 60-90 days after sowing among different tillage and bioregulators treatments.

Relative Water Content: Perusal of the data presented in Table 2 showed that there was a significant difference in RWC amongst tillage treatments where ZT+R treatment recorded significantly higher RWC as compared to ZT and CT. ZT+R treatment showed 7% higher relative water content in plant over CT treatment and 6% more over ZT at 45 DAS. Similarly, ZT+R treatment showed 6% higher relative water content in plant over CT treatment and 5% more over ZT. The ZT treatment remained at par with CT treatment which means zero tillage did not made any significant difference in relative water content of plant at 45 and 75 DAS. It may be due to mulching practices conserved more moisture during early growth stages resulting in better RWC in mulched plot over no mulch (Rathore *et al*., 1998) [9]. There was no significant difference in terms of relative water content of plant with bioregulators application at 45 DAS while at 75 DAS foliar application of salicylic acid (50 ppm) treatment increased the relative water content (62.33%) significantly in chickpea over control (59.03%) and K + multi-micronutrient complex and remained statistically at par with KNO3 (61.77%) and thiourea (61.43%). Patel (2011) [7] observed that salicylic acid helped in stomata functioning and regulates water balance in plants resulting in increase in relative water content in plant and resulted in enhanced growth and yield.

Canopy temperature: Canopy temperatures were taken ten days after pod filling stage at 10 day's interval until physiological maturity at 2 to 3 pm. There was approximately 2-4 °C difference between in air temperature and canopy temperature. Statistically analysis of tabular data (Table 2) indicated that ZT+R treatment significantly reduced plant canopy temperature by 1.82 °C over CT treatment and 1.69 °C over ZT treatment at 125 DAS whereas ZT+R treatment maintained same pattern with significantly reduction of 2.06 °C over CT and 1.82 °C over ZT treatment at 135 DAS. There was no significant difference observed between ZT and CT treatments. It may be due to ZT+R protected the plant from heat stress by maintaining transpiration and water regulation inside the plant as compared to CT treatments. Among bioregulators foliar application of thiourea (1000 ppm) at flowering and pod filling significantly reduced the canopy temperature by 1.6 °C over control at 125 DAS and 2.43 °C at 135 DAS with remained at par with K + multi-micronutrient complex (1%), KNO_3 (2%) and salicylic acid (50 ppm) treatment. Kumar (2020) [5] suggested that foliar application of thiourea (1000 ppm) ameliorates heat tolerance in chickpea by helping in boosting both photosynthetic activity and improvement in chlorophyll content and greenness.

Yield: Interaction (Table 3) effects on yield presented on bioregulators applications at same tillage level which showed that salicylic acid (50 ppm) indicated significantly highest grain yield over control (water spray) and at par with thiourea (1000 ppm), KNO_3 (2%) and K+ multi-micronutrient (1%) in CT treatment. Application of salicylic acid (50 ppm) under zero tillage treatment indicated significantly higher grain yield over thiourea (1000 ppm), KNO_3 (2%) K+ multi-micronutrient (1%) and control (water spray) while in ZR+R treatment, KNO_3 (2%) indicated significantly more yield as compared to thiourea (1000 ppm) and control (water spray) and remained at par with salicylic acid (50 ppm) and K+ multi-micronutrient (1%). Interaction effect showed that KNO_3 (2%) had significantly highest grains yield in ZT+R treatment as compared to ZT and CT treatment. It might be due to the integrated effect of KNO_3 (2%) application and ZT+R treatment by which foliar application of KNO_3 (2%) provided two major nutrients *viz*, potassium and nitrogen (NO_3^-) which helped in drought tolerance, dry matter accumulation, stomata regulation, maintained water balance, cell elongation and cell division, and higher chlorophyll content (Rao *et al.*, 2015) [8] and K^+ helped in carbohydrate distribution, photosynthesis and starch synthesis in storage organs assumed to be responsible for higher grain yield (Imas *et al.*, 2007) [3]. On contrary ZT+R treatment showed mulching effect and reduced the heat transmission in soil profile which may cause evaporation loss. ZT+R reduced water losses and enhanced in moisture availability to chickpea during critical stages along with this mulching also inhibit weed emergence by their smothering effect and black-gram straw added additional nutrient to the field thus all sum of these factors enhanced grain yield significantly.

Table 1: Effect of tillage and bioregulators on crop growth rate (g/m^2/day) and relative growth rate (mg/g/day) of chickpea

Treatment	0-30 DAS	30-60 DAS	60-90 DAS	30-60 DAS	60-90 DAS
Tillage					
CT - Conventional tillage	0.43	1.71	4.95	23.29	21.16
ZT - Zero tillage	0.44	1.78	5.62	23.51	21.01
ZT +R - Zero tillage + Residue	0.45	1.87	6.15	23.66	21.18
SEm±	0.01	0.04	0.16	0.43	0.26
LSD(P=0.05)	NS	NS	0.63	NS	NS
Bioregulators					
B_0 - Control (water spray)	0.44	1.79	4.84	23.03	21.22
B_1 - Salicylic acid (50 ppm)	0.46	1.79	6.09	23.14	21.57
B_2 - KNO_3 (2%)	0.44	1.81	6.04	23.86	20.97
B_3 - Thiourea (1000 ppm)	0.44	1.78	5.62	23.44	21.10
B_4 - K + multi-micronutrient (1%)	0.42	1.80	5.27	23.94	20.91
SEm±	0.01	0.02	0.16	0.32	0.32
LSD(P=0.05)	NS	NS	0.46	NS	NS

Table 2: Effect of tillage and bioregulators on relative water content (%) and canopy temperature (^{0}C) of chickpea

	RWC (%)		Canopy temperature (^{0}C)	
Treatment	**45 DAS**	**75 DAS**	**125 DAS**	**135 DAS**
Tillage				
CT - Conventional tillage	69.54	59.62	30.03	31.81
ZT - Zero tillage	70.30	60.26	29.90	31.57
ZT +R - Zero tillage + Residue	74.21	63.16	28.20	29.75
SEm±	0.95	0.72	0.38	0.43
LSD(P=0.05)	3.73	2.81	1.48	1.67
Bioregulators				
B_0 - Control (water spray)	71.57	59.03	30.22	32.61
B_1- Salicylic acid (50 ppm)	71.27	62.33	28.73	30.33
B_2- KNO_3 (2%)	71.13	61.77	29.27	30.60
B_3- Thiourea (1000 ppm)	71.51	61.43	28.60	30.18
B_4 - K + multi-micronutrient (1%)	71.27	60.50	30.06	31.50
SEm±	1.22	0.62	0.43	0.48
LSD(P=0.05)	NS	1.80	1.24	1.41
Atmospheric temperature			32.1	33.7

Table 3: Interaction effect of tillage and bioregulators on grain yield of chickpea.

Bioregulators applications					
Tillage	**Control (water spray)**	**Salicylic acid (50 ppm)**	**KNO_3 (2%)**	**Thiourea (1000 ppm)**	**K+multimicronutrient (1%)**
CT	8.1	9.2	8.9	9.1	8.6
ZT	8.9	10.9	9.8	9.5	9.0
ZT+R	10.1	11.9	12.5	10.7	11.6
				SEm±	LSD(0.05)
Bioregulator applications at same tillage level				0.33	0.97
Tillage at same or different bioregulator levels				0.42	1.38

Conclusion

Pulses are the rich source of protein (poor man's meat) as well as an important source of fiber, minerals, and vitamins. Among pulses, chickpea occupied most of the area comprising major contributor of total pulse production even grown in rainfed marginal soil. The results indicate that foliar application of KNO_3 (2%) at flower initiation and pod filling under ZT+R resulted in highest in grain yields

Acknowledgement

The authors are grateful to Rani Lakshmi Bai Central Agricultural University, Jhansi, India for providing land and facilities to this research we also sincerely acknowledge the ICAR- Indian Institute of Pulse Research and ICAR- Indian Grassland and Fodder Research Institute for providing all lab facilities.

References

1. Ahmad F, Gaur PM, Croser J. Chickpea (*Cicer arietinum* L.). Genetic resources, chromosome engineering, and crop improvement-grain legumes. 2005;1:187-217.
2. Gomez KA, Gomez AA. Statistical procedures for agricultural research. 2nd Ed., John Willey and Sons Inc. New York, USA; 1984. p. 680.
3. Imas P, Magen H. Management of potassium nutrition in balanced fertilization for soybean yield and quality – Global perspective. In: Proceedings of Regional Seminar on Recent Advances in Soybean-based cropping system. National Research Centre for Soybean, Indore, 2007, 1-20.
4. Kumar BR, Angadi SS. Effect of tillage, mulching and weed management practices on the performance and economics of chickpea. Legume Research: An International Journal. 2016, 39(5).
5. Kumar P, Yadav S, Singh MP. Bioregulators application improved heat tolerance and yield in chickpea (*Cicer arietinum* L.) by modulating zeaxanthin cycle. Plant Physiology Reports. 2020;25(4):677-688.
6. Pandey M, Srivastava AK, D'Souza SF, Penna S. Thiourea, a ROS scavenger, regulates source-to-sink relationship to enhance crop yield and oil content in *Brassica juncea* (L.). PloS one, 2013;8(9):e73921.
7. Patel PK, Hemantaranjan A, Sarma BK, Radha S. Growth and antioxidant system under drought stress in chickpea (*Cicer arietinum* L.) as sustained by salicylic acid. Journal of Stress Physiology & Biochemistry. 2011, 7(4).
8. Rao DSN, Naidu T, Rani YA. Effect of foliar nutrition on water potential, photosynthetic rate, dry matter production and yield of mung bean under receding soil moisture condition. International Journal of Applied Biology and Pharmaceutical Technology. 2015;6(2):16-22.
9. Rathore AL, Pal AR, Sahu KK. Tillage and mulching effects on water use, root growth and yield of rainfed mustard and chickpea grown after lowland rice. Journal of the Science of Food and Agriculture. 1998;78(2):149-161.
10. Thudi M, Upadhyaya HD, Rathore A, Gaur PM, Krishnamurthy L, Roorkiwal M, *et al*. Genetic dissection of drought and heat tolerance in chickpea through genome-wide and candidate gene-based association mapping approaches. Plos one. 2014;9(5):e96758.
11. Turner NC. Techniques and experimental approaches for the measurement of plant water status. Plant and soil. 1981;58(1):339-366.