JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

Impact of Minor Nutrients in Chickpea (*Cicer arietinum*) through Effective Nutrient Management

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Abstract

A field investigation on "Study of the Effect of Minor Nutrients in Chick pea (*Cicer arietinum*) through Nutrient Management" was carried out during the rabi season year of 2021-22 and 2022-23 at Research Farm of Experimental field at Bhagwant University, Ajmer, Rajastha. The soil of the experimental field was slightly saline in nature, pH was 6.67, moderately alkyl in EC 0.433 (dSm^{-1}) and low organic carbon 0.30 (%) as well as the initial soil fertility of the experimental field was low in available nitrogen 208.1 kg ha^{-1}, very high in available phosphorus 197 kg ha^{-1} and low in available potassium 139 kg ha^{-1}, available sulphur 188 kg ha- The field experiment was laid out in a randomized block design with three replications.

Among the different nutrient management treatments application of GRDF + soil application of multi-micronutrient Grade-II @ 10 kg ha-1 exhibited significantly higher plant height (57.93 cm), number of branches $plant^{-1}$ (22.26), spared $plant^{-1}$ (45.98 cm) and dry matter plant-1 (26.12 g) at harvest as compared to rest of nutrient management treatments during rabi 2021-2022. Chickpea crop with no fertilizer recorded significantly lower plant height (35.75 cm), number of branches $plant^{-1}$ (8.89), spread $plant^{-1}$ (25.02) and dry matter $plant^{-1}$ (12.63 g) The chickpea crop fertilized with GRDF + soil application of multi micronutrient Grade-II @ 10 kg ha^{-1} produced significantly higher grain yield (28.48 q ha^{-1}), straw yield (31.68 q ha^{-1}), biological (60.05 q ha^{-1}) and harvest index (47.33%) as compared to other nutrient management treatments under study. The maximum and significantly higher chlorophyll content i.e. 56.32 % was observed at 60 DAS when chickpea crop was fertilized with GRDF + soil application of multi micronutrient Grade-II @ 10 kg ha-1. While significantly minimum days for flower initiation (48.00 days), days to 50% flowering (54.68 days) and early maturity (101.00 days) were observed when chickpea crop was not fertilized with any nutrient.

INTRODUCTION-

Chickpea (*Cicer Arietinum* L.) is an annual legume crop of the family Fabaceae and subfamily Faboideae. As in the case of other legume crops, even chickpea can fix atmospheric nitrogen through its symbiotic association with Rhizobium sps. thus, helping in enhancing the fertility of the soil.

Chickpea occupies a prime position among the pulses in the country with maximum hectare production and its higher nutritive value. Chickpea has been supposed to be originated in south-eastern Turkey and migrated to other parts of the world.

Chickpea is a good source of carbohydrates and proteins, which together constitutes about 80% of the total dry seed mass. The starch content of chickpea cultivars has been reported to vary from 41 % to 50%. The crude protein content of chickpea where is from 12.4 to 31.5 percent. Chickpea contains about 6% fat which is important in vegetarian diets resource for consumers chickpea contains nutritionally important minerals, notably calcium and

iron, and the availability of iron is reported to be good. The protein quality is considered to be better than other pulses (Hirdyani, 2014).

Chickpea is the world's third most important cool season food legume crop. India is the largest producer contributing to 65% of the world's production (FAOSTAT, 2015).

Chickpea is primarily a rainfed crop, and water stress has a significant impact on chickpea productivity and yield stability. Rainfed soils are generally deteriorated, and native fertility is low (Valenciano *et al.*, 2010) Even though India is the largest producer of chickpea; it still imports chickpea from other countries. Improving the production and area under cultivation is essential while minimizing the stress on this crop plant chickpea.

Production 49.35% in the year 2020 total pulses production 8.12 million hectares with a production of 7.46 million tons. and productivity 895 kg ha-1. Rajasthan ranks third with 18.59 lakh hectares of area, production of 19.72 lakh tons and productivity 1061 kg ha^{-1}. (Annuai report, 2021).

Chickpea is cultivated mostly on residual fertility of Kharif season crop. Farmers are not well aware of the nutrient management of chickpeas. They apply only inadequate major nutrients to chickpeas. Four micronutrients i.e., Manganese (Mn), Iron (Fe), Copper (Cu), and Boron (B) are required for higher plants (Welch *et al.* 2005). This has been well documented to involve photosynthesis, nitrogen fixation, respiration, and another biochemical pathway (Foth and Ellis, 2006).

MATERIALS AND METHODS

The experiment was lied in Experimental field of Bhagwant University, Ajmer, Rajasthan. during *rabi* season 2021-22 and 2022-23 and Climatic condition during experiment was cold in November with minimum average temperature was (4.9 ^{0}C) and highest Temperature recorded in March with average of (39.0 ^{0}C).

The topography of the experimental field was uniform levelled and uniform in depth up to 60 cm. The type of soil is black soil developed from Volcanic rocks and lava- flow. the soil comes under the vertisole order. The soil of the experimental field was slightly saline in nature, pH was 7.01 and 6.67, moderately alkyl in EC 0.484 and 0.433 (dSm^{-1}) and low organic carbon 0.30 and 0.31 (%). The experiment was laid out in randomized block design with three replications. Eight treatment combinations were formed considering eight micronutrients treatment through different sources.

The initial and final plant count was recorded by counting all the plants from each net plot at 15 days after sowing and at harvest of the crop, respectively. For the purpose of measuring plant height, five plants were chosen carefully. Using a metric scale, the height of the plant was measured from the ground up to the tip of the stem in cm. Now, five selected plants were the subject of observations beginning on the 30th, 60th, and 90th day after sowing, as well as during harvest. Observations were then recorded every 30 days up until harvest. The typical plant height was calculated and noted. At 30, 60, 90, DAS, and harvest of five chosen plants, the number of branches was counted on a regular basis. An average branch count was calculated and recorded.

The number of days required the date of sowing and the day on when the seed embryos of the plants in each plot had reached physiological maturity was recorded based on visual observation. The net monetary returns (₹ ha^{-1}) for each treatment was worked out by deducting the cost of cultivation of each treatment from gross monetary returns of respective treatments.

Net monetary returns (₹ ha^{-1}) = Gross monetary returns (₹ ha^{-1}) - Cost of cultivation (₹ ha^{-1})

The benefit-cost ratio was worked out by taking into consideration the gross monetary returns and total cost of cultivation (₹ ha^{-1}) for each treatment using the formula given below.

$$\text{B:C Ratio} = \frac{\text{Gross monetary returns (₹ ha}^{-1}\text{)}}{\text{Cost of cultivation (₹ ha}^{-1}\text{)}}$$

RESULT AND DISCUSSION

Growth Parameter-

Plant Count-

The initial and final plant populations as influenced by different treatments are presented in table 7. The initial plant count and final plant count was (33.95 and 34.56 m^{-2}) and (30.86 and 32.58 m^{-2}) during both the years, respectively. The initial and final plant population was influenced significantly due to different nutrient management

treatments tried for chickpea. The uniform initial and final plant population of chickpea was observed due to different nutrient management treatments.

Table 1. Plant count of chickpea as influenced by different treatments.

Treatment	Initial plantcount m^{-2}		Final plant count m^{-2}	
	2021	2022	2021	2022
T1: Control	28.21	29.54	24.03	25.35
T2 : RDF (25:50:30 N :P_2O_5 :K_2O kg ha^{-1})	29.45	30.26	24.12	25.89
T3 : GRDF (25:50:30 N :P_2O_5 :K_2O kg ha^{-1} +FYM 5 ha^{-1})	30.25	31.24	24.47	26.21
T4 : GRDF + Chelated Fe EDTA 0.2 % (foliar spray)	32.52	31.56	24.28	25.91
T5 : GRDF + Chelated Zn EDTA 0.2 % (foliar spray)	33.67	34.25	25.54	27.85
T6 : GRDF + Boric acid 0.1 % (foliar spray)	31.82	32.26	24.76	26.87
T7 : GRDF + Multi micronutrient Grade-II 0.5 % (foliar spray)	32.97	32.98	30.46	31.25
T8 : GRDF + Multi micronutrient Grade-II @ 10 kg ha^{-1} (soil application)	33.95	34.56	30.86	32.58
S. Em ±	1.724	1.81	2.102	2.22
C.D. at 5 %	5.12	5.29	5.95	5.95

Plant height

The data in respect of plant height of chickpea as influenced periodically by different treatments are presented in table 8 and graphically depicted in fig. 4.1. The mean plant height was 20.50 and 21.26, 45.20 and 43.25, 54.80 and 55.48 and 57.93 and 58.94 cm at 30, 60, 90 DAS and at harvest, during both the years, respectively. The plant height was increased progressively with the advancement of age of the plant due to continuous growth habit of chickpea. Initially, the plant height was at lower magnitude up to 30 DAS. The plant growth rate in terms of plant height was more vigorous during the period of 30 to 90 DAS and thereafter, the rate of growth was decreased. The plant height was significantly influenced due to different nutrient management treatments for chickpea. The application of GRDF in association with soil application of multi-micronutrient Grade-I @ 10 kg ha-1 exhibited significantly higher plant height of chickpea at all growth stages. While GRDF + multi-micronutrient Grade-II 0.5 % (foliar spray) was found to be at par in recording plant height of chickpea at all the growth stages of chickpea except at 60 DAS and at harvest. While GRDF + Chelated Fe EDTA 0.2 % (foliar spray) and GRDF + Chelated Zn EDTA 0.2 % (foliar spray) were found at par at 30 DAS only. The minimum plant height of chickpea was recorded in the treatment absolute control were in no fertilizer were applied.

The increased plant height of chickpea in the application of GRDF + soil application of multi- micronutrient Grade-I @ 10 kg ha-1 was due to most favorable availability of micro nutrient as multi- micronutrient Grade-I contains precised amount of iron, zinc, copper, manganese, boron, molybdenum etc. also it was associated with 5 t ha-1 FYM which is also a source of micronutrients. This facilitated the availability of required micronutrients for the luxurious growth of chickpea. Iron plays important role in metabolism of chlorophyll while zinc is involved in carbohydrate metabolism, protein synthesis as well boron regulate transport of sugar through membrane, cell division, cell

development etc. Copper and manganese are essential for energy transfer and photosynthesis. Copper increases nodulation and nitrogen fixation while manganese is vital for protoplast metabolism.
The results are in agreement with Balachandar *et al.* (2003), Abraham and Abraham (2011) and Balai *et al.* (2017).

Table 2. Plant height of chickpea as influenced by different treatment.

TREATMENT	Plant Height (cm)							
	30 DAS		60 DAS		90 DAS		At Harvest	
	2021	2022	2021	2022	2021	2022	2021	2022
T_1 : Control	17.80	18.21	22.80	23.51	30.90	31.25	35.75	36.21
T_2 : RDF (25:50:30 N :P_2O_5 :K_2O kg ha^{-1})	18.0	18.57	34.11	35.65	38.60	39.51	44.30	45.24
T_3 : GRDF (25:50:30 N :P_2O_5 :K_2O kg ha^{-1} +FYM 5 tha^{-1})	18.4	19.25	39.00	40.25	44.70	45.51	50.40	51.23
T_4 : GRDF + Chelated Fe EDTA 0.2 % (foliarspray)	19.50	20.21	42.30	43.28	48.50	49.21	54.10	55.64
T_5 : GRDF + Chelated Zn EDTA 0.2 % (foliarspray)	19.50	20.87	41.30	42.85	50.80	51.35	53.70	54.28
T_6 : GRDF + Boric acid 0.1 % (foliar spray)	18.12	18.95	38.22	39.54	49.30	50.64	51.50	52.35
T_7 : GRDF + Multi micronutrient Grade-II0.5% (foliar spray)	19.80	20.58	41.80	42.41	54.50	55.52	55.50	56.48
T_8 : GRDF + Multi micronutrient Grade-II @ 10kg ha^{-1} (soil application)	20.50	21.26	45.20	43.25	54.80	55.48	57.93	58.94
S. Em ±	0.43	0.52	0.63	0.71	0.66	0.73	1.03	1.24
C.D. at 5 %	1.22	1.52	1.92	2.12	2.00	2.26	3.13	3.54

Dry matter plant^{-1}

Data regarding to dry matter plant-1 of chickpea as influenced by different treatments during rabi season, 2021-22 are presented in table 11 and graphically depicted in fig. 6. The mean dry matter plant-1 of chickpea was 1.23-1.75, 18.76-19.47, 21.71 -22.23 and 26.12-28.41 g at 30, 60, 90, DAS and at harvest during the years of investigation, respectively. The data in respect dry matter plant-1 in chickpea were influenced significantly due to different nutrient management treatments at all growth stages. The chickpea crop fertilized with GRDF + soil application of multi-micronutrient Grade- II @ 10 kg ha-1 produced significantly higher dry matter plant-1 of chickpea at all growth stages of the crop. While it was at par with GRDF + multi-micronutrient Grade-II 0.5 % (foliar spray) at 30, 90 DAS and at harvest, also with GRDF + cheated Fe EDTA 0.2 % (foliar spray) and with GRDF + cheated Zn EDTA 0.2 % (foliar spray) and also GRDF + boric acid 0.1 % (foliar spray) at 30 DAS only. No application of fertilizer to chickpea produced significantly minimum dry matter palnt^{-1} at all growth stages during the experimentation.
The dry matter of chickpea is product of luxurious plant growth and assimilation of photosynthates. Chickpea fertilized with GRDF + soil application of multi-micronutrient Grade-II @ 10 kg ha-1 enjoyed healthy crop growth due to sufficient availability of macro and micro nutrients. Enrichment of soil with macro and micro nutrients due to GRDF + soil application of multi- micronutrient Grade-I @ 10 kg ha-1 made it efficient utilization of macro and also micro nutrients. Iron enhanced chlorophyll metabolism, zinc is helpful in carbohydrate and protein synthesis and protected the chickpea crop against photo oxidative damage. Boron also regulated transport of sugar through membrane and played quite essential role for cell division and cell development. Copper and manganese played their role for energy transfer and photosynthesis. Copper increases nodulation and nitrogen fixation while manganese offers key role in protoplast metabolism.

The results are in close association with Singh and Gupta (1986), Velenciano *et al.* (2010) and Balai *et al.* (2017)

Table 3. Dry matter plant-1 of chickpea as influenced by different treatments

Treatment	Dry matter (g plant $^{-1}$)							
	30 DAS		60 DAS		90 DAS		At Harvest	
	2021	2022	2021	2022	2021	2022	2021	2022
T1 : Control	0.53	0.64	3.06	3.54	8.20	9.36	12.63	13.25
T2 : RDF (25:50:30 N :P_2O_5 :K_2O kg ha^{-1})	0.76	0.85	6.30	7.24	13.61	14.46	17.15	18.25
T3 : GRDF (25:50:30 N :P_2O_5 :K_2O kg ha^{-1} + FYM 5 tha^{-1})	1.06	1.26	11.20	12.35	19.80	20.21	21.76	22.54
T4 : GRDF + Chelated Fe EDTA 0.2 % (foliar spray)	1.12	1.37	14.98	15.54	20.69	21.54	23.72	24.57
T5 : GRDF + Chelated Zn EDTA 0.2 % (foliar spray)	1.11	1.28	13.89	14.23	20.43	21.25	23.71	24.46
T6 : GRDF + Boric acid 0.1 % (foliar spray)	1.09	1.24	13.00	14.06	19.93	20.12	21.89	22.23
T7 : GRDF + Multi micronutrient Grade-II 0.5 % (foliar spray)	1.18	1.45	17.24	18.29	21.05	21.89	25.72	26.58
T8 : GRDF + Multi micronutrient Grade-II @ 10 kg ha^{-1}(soil application)	1.23	1.75	18.76	19.47	21.71	22.23	26.12	28.41
S. Em ±	0.01	0.04	0.32	0.45	0.40	0.38	0.38	0.56
C.D. at 5 %	0.04	0.12	0.98	1.31	1.22	0.98	1.16	1.54

Physiological maturity

Data regarding days to physiological maturity of chickpea as influenced by different treatments during rabi season, 2021-22 and 2022-23 are presented in table 12. The mean days to physiological maturity of chickpea were 104.71 and 106.41 days during both years of investigation. The data in respect days to physiological maturity in chickpea were influenced significantly due to different nutrient management treatments.

The chickpea with no fertilizer required significantly minimum number days (101.00 and 101.54 days) for physiological maturity during rabi 2021-22 and 2022-23 as compared to other nutrient management treatments. Significantly maximum number of days (104.71 and 106.41 days) required for chickpea crop fertilized with GRDF + soil application of multi-micronutrient Grade-II @ 10 kg ha^{-1}. The chickpea crop without fertilizer shortened its vegetative growth phase due to lesser availability of macro and micro nutrients specially and due to nutrient stress, it was reflected in earlier physiological maturity.

Table 4. Days to flower initiation, 50 % flowering and physiological maturity of chickpea as influenced by different treatments.

Treatment	Days to physiological maturity	
	2021	2022
T1: Control	101.00	101.54
T2: RDF (25:50:30 N :P_2O_5 :K_2O kg ha^{-1})	101.67	101.88
T3: GRDF (25:50:30 N :P_2O_5 :K_2O kg ha^{-1} +FYM 5 t ha^{-1})	102.61	102.76
T4: GRDF + Chelated Fe EDTA 0.2 % (foliarspray)	103.33	104.21
T5: GRDF + Chelated Zn EDTA 0.2 % (foliarspray)	103.33	104.41
T6: GRDF + Boric acid 0.1 % (foliar spray)	103.00	104.05
T7: GRDF + Multi micronutrient Grade-II 0.5 % (foliar spray)	103.67	105.25
T8: GRDF + Multi micronutrient Grade-II @10 kg ha^{-1} (soil application)	104.71	106.41
S. Em ±	1.37	1.12
C.D. at 5 %	3.85	3.32

Weight of pods plant-1

Data regarding to weight of pods plant-1 of chickpea as influenced by different treatments during rabi season, 2021-22 and 2022-23 are presented in table 13 and graphically depicted in fig. 8. The mean weight of pods plant-1 of chickpea was 12.23 g during both the years, respectively. The data in respect of pods plant $^{-1}$ in chickpea were influenced significantly due to different nutrient management treatments.

The chickpea crop fertilized with GRDF + soil application of multi-micronutrient Grade-II @ 10 kg ha-1 produced significantly highest weight of pods plant-1 (16.09 and 18.25 g) as compared to rest of the nutrient management treatments during both the years, respectively. No application of fertilizer to chickpea produced significantly minimum weight of pods palnt-1. The chickpea fertilized with GRDF + soil application of multi-micronutrient Grade- II @ 10 kg ha-1 experienced luxurious availability of macro and micronutrients and produced maximum weight of pods plant-1. Iron played vital role in chlorophyll metabolism, which favored more photosynthesis. Zinc is vital for carbohydrate and protein assimilation as well as pollen formation. Boron regulated transport of photosynthates and also cell development. Copper and manganese are essential for energy transfer and photosynthesis. Copper is helpful for nodulation and nitrogen fixation while manganese is essential for protoplast metabolism. The results are in close association with Gupta and Sahu (2012), Morad *et al.* (2015) and Balai *et al.* (2017).

Grain weight plant-1

Data regarding grain weight plant-1 of chickpea as influenced by different treatments during rabi season, 2021-22 and 2022-23 are presented in table 13 and graphically depicted in fig. 8. The mean grain weight plant-1 of chickpea was 9.02 g during both the years, respectively. The data in respect grain weight plant-1 in chickpea were influenced significantly due to different nutrient management treatments.

The chickpea crop fertilized with GRDF + soil application of multi-micronutrient Grade-II @ 10 kg ha-1 produced significantly higher grain weight plant-1 (11.76 and 12.35 g) as compared to rest of the nutrient management treatments during both the years, respectively. No application of fertilizer to chickpea produced significantly minimum grain weight palnt-1. The chickpea crop fertilized with GRDF + soil application of multi-micronutrient Grade-II @ 10 kg ha-1 exerted healthy crop growth due to efficient utilization of macro as well as micro nutrients. The easy availability of iron, zinc, boron, copper etc. facilitated chlorophyll metabolism, which favoured maximum photosynthesis, carbohydrate and protein synthesis, transport of sugars, cell development, auxin

metabolism. Copper and manganese played their role for energy transfer and photosynthesis. Copper required for higher nodulation and nitrogen fixation while manganese is essential for protoplast metabolism. This reflected in luxurious crop achieving higher grain weight plant-1.

The results are in close association with Balachandar *et al.* (2003), Valenciano *et al.* (2010), Morad *et al.* (2015) and Balai *et al.* (2017).

Table 5. Yield attributes of chickpea as influenced by different treatment.

Treatment	Weight of pods plant^{-1} (g)		Grain weight plant^{-1} (g)	
	2021	2022	2021	2022
T1: Control	5.12	6.71	3.91	4.21
T2: RDF (25:50:30 N :P_2O_5 :K_2O kg ha^{-1})	8.06	9.23	6.25	6.84
T3: GRDF (25:50:30 N :P_2O_5 :K_2O Kgha^{-1} + FYM 5 t ha^{-1})	11.62	12.35	9.66	10.12
T4: GRDF + Chelated Fe EDTA 0.2 % (foliarspray)	14.52	15.84	10.45	11.24
T5: GRDF + Chelated Zn EDTA 0.2 % (foliarspray)	13.91	14.67	9.89	10.31
T6: GRDF + Boric acid 0.1 % (foliar spray)	13.69	14.21	9.62	10.04
T7: GRDF + Multi micronutrient Grade-II 0.5 % (foliar spray)	14.86	16.51	10.68	11.12
T8: GRDF + Multi micronutrient Grade-II @ 10 kg ha^{-1} (soil application)	16.09	18.25	11.76	12.35
S. Em ±	0.28	0.31	0.17	0.31
C.D. at 5 %	0.87	0.95	0.52	0.94

Grain yield

Data regarding grain yield of chickpea as influenced by different treatments during rabi season, 2021-22 and 2022-23 are presented in table 14 and graphically depicted in fig. 9. The data in respect grain yield of chickpea were influenced significantly due to different nutrient management treatments.

The chickpea crop fertilized with GRDF + soil application of multi-micronutrient Grade- II @ 10 kg ha-1 recorded significantly maximum grain yield (28.48 and 29.84 q ha-1) as compared to rest of the nutrient management treatments during both the years, respectively. No application of fertilizer to chickpea produced significantly minimum grain yield. The grain yield of chickpea is function luxurious growth, dry matter accumulation, yield attributes and physiological characters. The nutrient management to chickpea in terms of GRDF + soil application of multi-micronutrient Grade-II @ 10 kg ha-1 exhibited healthy crop growth, the sufficient availability of macro as well as micro nutrients and its efficient utilization by chickpea crop reflected in higher magnitude of growth and yield attributes as chlorophyll metabolism and more photosynthesis is facilitated due to iron. Carbohydrate and protein synthesis is a function of zinc. while boron regulated transport of sugar and cell division and cell development. Copper and manganese are essential for energy transfer and photosynthesis. Copper is helpful to increase nodulation and nitrogen fixation, while manganese is vital for protoplast metabolism. Thus there was cumulative effect in the production of higher grain yield of chickpea than other nutrient management treatments. The chickpea crop fertilized with GRDF + soil application of multi- micronutrient Grade-I @ 10 kg ha^{-1} recorded 55.49 and 56.84 % more grain yield as compared to recommended dose of fertilizer.

The results are in close association with Patel and Singh (2010), Valenciano *et al.* (2010) and Gupta and Sahu (2012).

Biological yield

Data regarding biological yield of chickpea as influenced by different treatments during *rabi* season, 2021-2022 and 2022-23 are presented in table 14 and graphically depicted in fig.9. The data in respect of straw yield of chickpea were influenced significantly due to different nutrient management treatments The application of fertilizer in terms of GRDF + soil application of multi- micronutrient Grade-I @ 10 kg ha-1 to chickpea crop recorded significantly maximum biological yield (60.05 and 61.21 q ha-1) as compared to rest of the nutrient management treatments during both the years, respectively. No application of fertilizer to chickpea produced significantly minimum biological yield.

Biological yield is function of grain and straw yield of chickpea. The chickpea crop fertilized with GRDF + soil application of multi-micronutrient Grade-II @ 10 kg ha-1 produced higher quantity of grain and straw yield due to the healthy crop growth which was reflected in higher biological yield.

The results are in close association with Gupta and Sahu (2012) and Balai *et al.* (2017).

Table 6. Yield and harvest index of chickpea as influenced by different treatment

Treatment	Yield (q ha^{-1})			
	Grain		Biologicalyield	
	2021	2022	2021	2022
T1: Control	12.68	12.71	32.06	32.24
T2: RDF (25:50:30 N :P_2O_5 :K_2O Kg ha^{-1})	18.31	18.37	44.94	45.21
T3: GRDF (25:50:30 N :P_2O_5 :K_2O kg ha^{-1} + FYM 5 t ha^{-1})	21.93	22.10	49.57	50.35
T4: GRDF + Chelated Fe EDTA 0.2 % (foliar spray)	24.85	25.10	52.99	53.65
T5: GRDF + Chelated Zn EDTA 0.2 % (foliar spray)	24.67	24.87	52.79	53.61
T6: GRDF + Boric acid 0.1% (foliar spray)	24.12	24.45	51.81	52.71
T7: GRDF + Multi micronutrient Grade-II 0.5 % (foliar spray)	25.46	26.23	54.12	55.76
T8: GRDF + Multi micronutrient Grade II @ 10 kg ha^{-1} (soil application)	28.48	29.84	60.05	61.21
S. Em ±	0.48	0.51	0.79	0.91
C.D. at 5 %	1.46	1.52	2.39	2.75

Nitrogen content in grain and straw

Data regarding nitrogen content in grain and straw of chickpea as influenced by different treatments during rabi season, 2021-2022 and 2022-23 are presented in table 17 and graphically depicted in fig. 12. The data in respect nitrogen content in grain and straw of chickpea were influenced significantly due to different nutrient management treatments.

The chickpea crop fertilized with GRDF + soil application of multi-micronutrient Grade- II @ 10 kg ha-1 noticed significantly higher values of nitrogen content in grain (3.48 and 3.54 %) and straw (1.28 and 1.31 %) as compared to rest of the nutrient management treatments during both the years of investigation, respectively. While it was at par with chickpea crop fertilized with GRDF + multi-micronutrient Grade-II 0.5 % (foliar spray) (3.35-3.45 and 1.26-1.28 %, respectively). The chickpea fertilized with GRDF + soil application of multi-micronutrient Grade-II @ 10 kg ha-1 and GRDF + multi-micronutrient Grade-II 0.5 % (foliar spray) enjoyed healthy availability of macro as well as essential micro nutrients. The iron and zinc played vital role in nitrogen assimilation and protein synthesis. Copper and manganese are essential for energy transfer and photosynthesis. Copper increases nodulation and nitrogen fixation while manganese is vital for protoplast metabolism which reflected in the results. No application of fertilizers to chickpea produced significantly minimum nitrogen content in grain and straw of

chickpea. The initial value of nitrogen content in chickpea grain was 2.68 and 2.71 % which was at lower magnitude during both the years of investigation, respectively.

The results are in close association with Jain *et al.* (2007), Gupta *et al.* (2012) and Khan *et al.* (2014).

Table.7. Nitrogen, phosphorus and potassium content in grain and straw of chickpea asinfluenced by different treatments.

Treatment	N (%)				P (%)				K (%)			
	Grain		Straw		Grain		Straw		Grain		Straw	
	2021	2022	2021	2022	2021	2022	2021	2022	2021	2022	2021	2022
T1: Control	2.68	2.71	1.09	1.11	0.39	0.40	0.31	0.32	0.52	0.53	0.82	0.81
T2: RDF (25:50:30 N:P_2O_5:K_2O kg ha^{-1})	2.78	2.84	1.13	1.14	0.44	0.45	0.32	0.33	0.61	0.62	0.84	0.85
T3: GRDF (25:50:30 N: P_2O_5:K_2O kg ha^{-1}+ FYM 5 t ha^{-1})	3.00	3.10	1.14	1.15	0.45	0.46	0.33	0.34	0.63	0.64	0.87	0.88
T4: GRDF + Chelated Fe EDTA 0.2 %(foliar spray)	3.20	3.28	1.17	1.18	0.47	0.47	0.36	0.37	0.71	0.74	0.92	0.93
T5: GRDF + Chelated Zn EDTA 0.2 % (foliar spray)	3.18	3.31	1.19	1.23	0.45	0.46	0.35	0.36	0.67	0.69	0.9	0.91
T6: GRDF + Boric acid 0.1 % (foliar spray)	3.16	3.18	1.21	1.24	0.44	0.45	0.36	0.37	0.65	0.66	0.89	0.90
T7: GRDF + Multi micronutrient Grade-II 0.5 % (foliar spray)	3.35	3.45	1.26	1.28	0.48	04.9	0.39	0.41	0.74	0.79	0.94	0.96
T8: GRDF + Multi micronutrient Grade-II @ 10 kg ha^{-1} (soil application)	3.48	3.54	1.28	1.31	0.50	0.51	0.40	0.41	0.77	0.81	0.96	0.97
S. Em ±	0.077	0.081	0.016	0.016	0.010	0.011	0.006	0.007	0.014	0.013	0.008	0.009
C.D. at 5 %	0.235	0.241	0.047	0.048	0.030	0.033	0.019	0.021	0.045	0.039	0.026	0.026

Phosphorus content in grain and straw

Data regarding phosphorus content in grain and straw of chickpea as influenced by different treatments during rabi season, 2021-2022 and 2022-23 are presented in table 17 and graphically depicted in fig.13. The data in respect phosphorus content in grain and straw of chickpea were influenced significantly due to different nutrient management treatments.

The chickpea crop fertilized with GRDF + soil application of multi-micronutrient Grade- II @ 10 kg ha-1 noticed significantly higher values of phosphorus content in grain (0.50 and 0.51 %) and straw (0.40 and 0.41 %) as compared to rest of the nutrient management treatments during both the years of investigation, respectively. The chickpea fertilized with GRDF + soil application of multi-micronutrient Grade-II @ 10 kg ha-1 enriched the phosphorous content in grain and straw of chickpea due to efficient availability of phosphorus to chickpea. No application of fertilizer to chickpea produced significantly minimum phosphorus content in grain and straw of chickpea. The initial value of phosphorus content was 0.39 and 0.40 % which was at lower magnitude during both the years of investigation, respectively.

The results are in close association with Jain *et al.* (2007), Aysen Akay (2011) and Gupta *et al.* (2012).

Potassium content in grain and straw

Data regarding potassium content in grain and straw of chickpea as influenced by different treatments during rabi season, 2021-2022 and 2022-23 are presented in table 17 and graphically depicted in fig. 14. The data in respect

potassium content in grain and straw of chickpea were influenced significantly due to different nutrient management treatments.

The chickpea crop fertilized with GRDF + soil application of multi-micronutrient Grade- II @ 10 kg ha-1 noticed significantly higher values of potassium content in grain (0.77 and 0.81 %) and straw (0.96 and 0.97%) which is at par with GRDF + multi-micronutrient Grade-II 0.5 % (foliar spray) during both the years of investigation, respectively. The chickpea fertilized with GRDF + soil application multi-micronutrient Grade-I @ 10 kg ha-1 and GRDF + multi-micronutrient Grade-II 0.5 % (foliar spray) experienced efficient availability and utilization of potassium which was reflected in enrichment of grain and straw of chickpea. No application of fertilizer to chickpea produced significantly minimum potassium content in grain and straw of chickpea. The initial value of potassium content in grain of chickpea was 0.52 and 0.53 % which was at lower magnitude during both the years of investigation, respectively.

The results are in close association with Henda *et al.* (2004), Patel and Singh (2010), Gupta *et al.* (2012) and Balai *et al.* (2017).

CONCLUSION-

Chickpea crop fertilized with GRDF + soil application of multi micronutrient Grade-II @ 10 kg ha^{-1} recorded significantly higher values of growth attributes viz., plant height (57.93 and 58.94 cm), and dry matter plant-1 (26.12 and 28.41 g). The chickpea with no fertilizer showed early maturity (101.00 and 101.54 days). Chickpea crop fertilized with GRDF + soil application of multi micronutrient Grade-II @ 10 kg ha-1 exhibited significantly higher values of yield attributes of chickpea viz., weight of pods plant-1 (16.09 and 18.25 g) and grain weight plant-1 (11.76 and 12.35 g). Chickpea crop fertilized with GRDF + soil application of multi micronutrient Grade-II @ 10 kg ha-1 produced significantly higher grain yield (28.48 and 29.84 q ha-1), and biological yield (60.05 and 61.21 q ha-1). The chickpea crop fertilized with GRDF + soil application of multi micronutrient Grade-II @ 10 kg ha-1 recorded 55.49 and 57.25 % more grain yield as compared to recommended dose of fertilizer. Chickpea crop fertilized with GRDF + soil application of multi micronutrient Grade-II @ 10 kg ha-1 exhibited significantly higher values of nitrogen content in grain (3.48 and 3.54 %) and straw (1.28 and 1.31 %, respectively, phosphorus content in grain (0.50 and 0.51 %) and straw (0.40 and 0.41 %) respectively and potassium content in grain (0.77 and 0.81 %) and straw (0.96 and 0.97 %), respectively.

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