Journal of AgriSearch, 9 (1): 29-36
An Open Access International Peer Reviewed Quarterly

ISSN : 2348-8808 (Print), 2348-8867 (Online)
https://doi.org/10.21921/jas.v9i01.9889

Chickpea Performance as Influenced by Nutrient Management and their Residual Effects on succeeding Fodder Sorghum

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ABSTRACT

A field experiment was conducted at Agricultural Research Station, Anand Agricultural University, Derol during the rabi and summer seasons of 2013-14 and 2014-15 to determine the effect of inorganic fertilizer, biofertilizers, and micronutrients, as well as their interactions, on chickpea growth, yield attributes, and yield, as well as their residual effect on succeeding fodder sorghum. Results indicated that fertilizer levels treatment F_3 i.e., 100 % RDF (25-50 kg NP ha^{-1}) had significant influence on growth and yield attributing characters like plant height, number of branches $plant^{-1}$, number of nodules $plant^{-1}$, number of pods $plant^{-1}$ and also on seed and straw yields of chickpea as compared to treatments F_2 (75 % RDF), F_1 (50 % RDF) and F_0 (Control). The residual effect of treatment F_3 (100% RDF) had also significant influence on the green fodder yield, dry fodder yield and crude protein content of succeeding fodder sorghum. When compared to B0 (control), the biofertilizers treatment B1 (PSB + Rhizobium @ 5 ml kg-1 seed each) produced significantly higher growth, yield, and yield of chickpea. Application of micronutrients treatment M_1 (Micronutrient mixture grade-V @ 20 kg ha^{-1}) produced significantly higher number of branches $plant^{-1}$, number of nodules $plant^{-1}$ number of pod $plant^{-1}$, seed yield and straw yield as compared to untreated control (M_0). Treatment combination $F_3B_1M_1$ produced significantly the highest nodules $plant^{-1}$, number of pods $plant^{-1}$, seed and straw yields of chickpea, but it was statistically at par with treatment combination $F_2B_1M_1$ during both the years and on pooled basis.

ARTICLE INFO

Received on	:	01.01.2022
Accepted on	:	05.02.2022
Published online	:	16.03.2022

INTRODUCTION

Chickpea (*Cicer arietinum* L.) also known as Bengal gram or Chana is an important and unique food legume that is used in variety of food products such as snacks, sweets, condiments, vegetables etc. It is also consumed in the form of processed whole seed (boiled, roasted, parched, fried, steamed sprouted etc.) or as dal flour (besan). Chickpea is a good source of protein (18-22 per cent), carbohydrate (52-70 per cent), fat (4-10 percent), minerals and vitamins. It is also an excellent animal feed and its straw has good forage value. Chickpea (*Cicer arietinum* L.) is an ancient crop and has been grown in India, middle East and the parts of Africa for many years. In India, chickpea is cultivated in about 10.17 million hectares, producing 11.35 million tons of seeds with the productivity of 1116 kg ha^{-1}. In Gujarat, chickpea is grown in an area of 0.41 million hectares, producing 0.64 million tonnes with the productivity of 1574 kg ha^{-1} (Anonymous, 2020) .

Despite its importance in our daily nutrition and agricultural production, this crop's productivity in India and Gujarat is quite poor. Integrated nutrient management is a key aspect in enhancing chickpea output among the different factors impacting crop productivity. Balanced use of nutrients in the form of inorganic fertilizers, biofertilizers and micronutrients may beneficial for increasing the crop production. Crop and livestock enterprises are two functional components of the mixed farming system in India that determine the agricultural ecological balance. The production of fodder is the backbone of the livestock industry. In the recent past, most research has focused on the nutrient requirements of a single crop, and fertilizer recommendations have been established based on the fertilizer response of a single crop without taking preceding crops into account. As a result, fertilizer recommendations have been issued that are often excessive and uneconomic. Now, it is realized that when the crops are grown in a system, the fertilizer need of an individual crop cannot be precisely determined without taking into account the cropping sequence as a whole. Under irrigated conditions, there is a scope for growing another short duration crop like fodder sorghum (*Sorghum bicolor* L.) after chickpea. The growing of chickpea and fodder sorghum in a sequence will helps in sustaining the productivity of the soil in long run.

With this background, field experiments was planned and conducted during 2013-14 and 2014-15 at Agricultural Research Station, Anand Agricultural University, Derol, Dist. Panchmahal (Gujarat) under middle Gujarat conditions.

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MATERIALS AND METHODS

A field experiment was conducted during the rabi and summer seasons of 2013-14 and 2014-15 at Agricultural Research Station, Anand Agricultural University, Derol-389 320, Taluka: Kalol, Dist.: Panchmahal (Gujarat). The experimental field had an even topography with a gentle slope (1 %) having good drainage. The soil is representative of the region and is locally known as Goradu soil. The soil is very deep, fairly moisture retentive and responds well to manuring and fertilizers. It is suitable for all the crops of tropical and subtropical regions. The soil of the experimental field was loamy sand in texture, low in organic C (0.25 %), while, medium in available phosphorus (43.03 kg ha^{-1}) and available potassium (151.40 kg ha^{-1}). The soil was low in respect to available Fe (3.78 ppm) and available Mn (4.90 ppm), whereas it was high in available Zn (1.36 ppm) and available Cu (1.12 ppm). The soil was slightly alkaline in reaction (7.9 pH). The experiment was laid out in factorial randomized block design with three replications. There were sixteen treatment combinations comprised of four treatments of fertilizers levels (F_3-100 % RDF i.e., 25-50 kg NP ha^{-1}, F_2-75 % RDF i.e., 18.75-37.5 kg NP ha^{-1}, F_1 -50 % RDF i.e., 12.5-25 kg NP ha^{-1} and F_0 – Control), two biofertilizers treatments (B_1- PSB + Rhizobium @ 5 ml kg^{-1} seed each and B_0 - Control) and two micronutrients treatments (M_1 - Micronutrient mixture grade-V @ 20 kg ha^{-1} and M_0- Control) applied on preceding rabi chickpea and their residual effect was evaluated on succeeding fodder sorghum crop in summer season. The pure seeds of chickpea: GG 1 was used in the experiment. Sowing was done manually in line in the previously opened furrows at 45 cm apart using the seed rate of 60 kg ha^{-1}.Minor gap filling of chickpea was carried out at 10 days after sowing to maintain full plant population and thinning was carried at 20 days after sowing keeping healthy plants. The fertilizer application was given as per the treatments. After harvest of the rabi chickpea, the fixed plots were cultivated with power tiller without disturbing the bunds of previous plots of chickpea. Furrows were opened in each plot at 30 cm apart and seeds of fodder sorghum variety S-1049 were sown manually in the previously opened furrows of each plot using seed rate of 60 kg ha^{-1}. The succeeding fodder sorghum crop was commonly fertilized with 50 % RDF i.e., 40-20 NP kg ha^{-1}. All the recommended cultural practices were followed for both chickpea and fodder sorghum crop.

RESULTS AND DISCUSSION

Effect of fertilizer levels

Growth attributes of chickpea such as, plant height (at 60 DAS), plant height (at harvest) as well as number of branches plant^{-1} were significantly influenced due to fertilizer levels treatment F_3 (100% RDF) as compared to rest of the treatments i.e., F_2 (75 % RDF), F_1 (50% RDF) & F_0 (Control), whereas, non-significant effect was found in respect of plant height measured at 30 DAS. Treatment F_3 (100% RDF) recorded significantly the highest plant height at 60 DAS i.e., 37.31 cm, 37.34 cm and 37.33 cm, plant height at harvest i.e., 56.74 cm, 56.78 cm and 56.76 cm as well as number of branches plant^{-1}i.e., 12.03, 12.27 and 12.15 during 2013-14, 2014-15 and in pooled analysis, respectively over rest of the treatments (Table 1). On the basis of the role of N and P in the plant body, this type of behavior might be explained. Nitrogen is a necessary component of nucleic acids and proteins, both of which are critical for growth. This could also be linked to the fact that higher nitrogen levels resulted in faster cell division and elongation. Similarly, phosphorus aided in the early stages of the crop's establishment by encouraging root growth. The results presented here are very similar to those published by Tripathi *et al* (2013). Significantly the highest number of nodules plant^{-1} i.e., 17.25, 17.55 and 17.40 during 2013-14, 2014-15 and in pooled results, respectively were recorded under treatment F_3 (100 % RDF) as compared to other treatments (Table 2). This could be owing to phosphorus's favourable influence on root growth, which created more root surface for bacterial invasion and improved nodulation. Tripathi *et al* (2013), Das *et al* (2013) and Kumar *et al* (2015) found similar results.

The number of pods per plant^{-1} was found to be highly correlated to seed yield, making it a crucial yield parameter. Treatment F_3 (100 % RDF) produced significantly the highest number of pods plant^{-1} i.e., 84.10, 83.87 and 83.98 during 2013-14, 2014-15 and in pooled results, respectively as compared to rest of the treatments (Table 2). Nitrogen being an essential part of nucleic acids and proteins which are very important in promoting the growth and development and at initial stage phosphorus helped on promoting root growth and better establishment of crop. Further, as soil of the experimental plot was low in organic C (0.25 %) and medium in available phosphorus (43.03 kg ha^{-1}), the higher doses also elicit significant crop response in terms of higher yield attributes. These all-combined effects were found conductive for plant growth and development. These results are in accordance with those reported by Das *et al* (2013), Tripathi *et al* (2013) and Kumar *et al* (2015).

The seed yield of chickpea was significantly increased with the application of 100 % RDF i.e., 2503, 2483 and 2493 kg ha^{-1} during 2013-14, 2014-15 and in pooled analysis, respectively among the rest of the treatments (Table 2). The seed yield increased under F_3 (100 % RDF) were 9.01, 23.72 and 38.42 per cent over F_2, F_1 and F_0, respectively on pooled basis. Similarly, Treatment F_3 (100 % RDF) produced significantly the highest straw yield i.e., 3023, 2980 and 3001 kg ha^{-1} during 2013-14, 2014-15 and in pooled analysis, respectively among the other fertilizer levels treatments. The increases in straw yield under F_3 (100 % RDF) were 8.30, 21.69 and 35.73 per cent over F_2 (75 % RDF), F_1 (50 % RDF) and F_0 (control), respectively on pooled basis. The process of tissue differentiation from stomatic to reproductive, meristematic activity, and formation of floral primordial may have been aided by increased fertilizer application, resulting in a high number of flowers, which later matured into pods.

Table 1: Plant height at 30 DAS, 60 DAS, at harvest and number of branches plant^{-1} as influenced by fertilizer levels, biofertilizers and micronutrients

Treatments	Plant height at 30 DAS (cm)			Plant height at 60 DAS (cm)			Plant height at harvest (cm)			Number of branches plant^{-1}		
	2013-14	2014-15	Pooled	2013-14	2014-15	Pooled	2013-14	2014-15	Pooled	2013-14	2014-15	Pooled
Fertilizer levels (F)												
F_0	13.12	13.33	13.23	32.68	32.08	32.38	50.12	49.22	49.67	9.42	9.50	9.46
F_1	13.41	13.48	13.44	33.72	33.82	33.77	51.95	52.10	52.03	10.65	10.97	10.81
F_2	13.43	13.50	13.46	34.60	34.63	34.61	53.66	53.70	53.68	10.68	11.30	10.99
F_3	13.53	13.58	13.55	37.31	37.34	37.33	56.74	56.78	56.76	12.03	12.27	12.15
S. Em.+	0.21	0.24	0.16	0.62	0.60	0.43	0.92	0.91	0.65	0.28	0.28	0.20
C.D. (P= 0.05)	NS	NS	NS	1.79	1.73	1.22	2.65	2.63	1.83	0.81	0.82	0.57
Biofertilizers (B)												
B_0	13.26	13.43	13.34	33.82	33.32	33.57	51.91	51.16	51.53	10.12	10.37	10.24
B_1	13.48	13.51	13.50	35.33	35.61	35.47	54.33	54.74	54.54	11.28	11.65	11.46
S.Em.+	0.15	0.17	0.11	0.44	0.42	0.31	0.65	0.64	0.46	0.20	0.20	0.14
C.D. (P= 0.05)	NS	NS	NS	1.27	1.22	0.86	1.87	1.86	1.29	0.58	0.58	0.40
Micronutrients (M)												
M_0	13.28	13.44	13.36	34.13	34.11	34.12	52.44	52.42	52.43	10.30	10.59	10.45
M_1	13.46	13.50	13.48	35.02	34.82	34.92	53.79	53.49	53.64	11.09	11.43	11.26
S.Em.+	0.15	0.17	0.11	0.44	0.42	0.31	0.65	0.64	0.46	0.20	0.20	0.14
C.D. (P= 0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	0.58	0.58	0.40
Interactions												
F × B × M	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
C.V.%	5.41	6.16	5.80	6.23	6.02	6.12	5.98	5.95	5.96	9.12	8.92	9.02

Furthermore, under conditions of increased nutrient availability, photosynthates may be more efficiently transported from leaves to the stalk site, which includes the pod and seeds. Fertilizer application influenced these characteristics in a positive way. Thus, overall better growth performance and higher values of most of the yield attributes under higher levels of fertilizer resulted into significantly the highest yield. Positive response of crops in terms of growth, yield attributes and yield to levels of fertilizer has also been reported by Chaudhari *et al* (1998), Das *et al* (2013), Shukla *et al* (2013), Tripathi *et al* (2013) , Kumar *et al* (2015) and Dewangan *et al* (2017).

In succeeding fodder sorghum, the results showed that treatment F_3 (100% RDF) recorded significantly the highest green fodder yield (310 q ha^{-1}, 319 q ha^{-1} and 315 q ha^{-1}),dry fodder yield (105 q ha^{-1},107 q ha^{-1} and 106 q ha^{-1}) and crude protein content (6.02 % ,5.98 % and 6.0 %) of fodder sorghum during the years 2013-14, 2014-15 and on pooled basis respectively over rest of the fertilizer levels treatments (Table 4). The increase in green and dry fodder yields of fodder sorghum due to treatment F_3 (100 % RDF) given to preceding chickpea might be ascribed to addition of nitrogen and also left over residual N and P applied to chickpea, which accounted for significant improvement in growth and yield attributes and finally resulted in higher green and dry fodder yields. In addition, also this might be attributed to addition of nitrogen in soil through higher number of root nodules plant^{-1} and chickpea residues (roots, stubbles and leaves). This clearly brought out the crucial role of legumes in cropping system. The results are in agreement with the results of Pankhaniya

Table 2: Number of nodules plant^{-1}, number of pods plant^{-1}, seed yield and straw yield as influenced by fertilizer levels, biofertilizers and micronutrients

Treatments	Number of nodules plant^{-1}			Number of pods plant^{-1}			Seed yield (kg ha^{-1})			Straw yield (kg ha^{-1})		
	2013-14	2014-15	Pooled	2013-14	2014-15	Pooled	2013-14	2014-15	Pooled	2013-14	2014-15	Pooled
Fertilizer levels (F)												
F_0	12.45	12.50	12.48	67.50	67.48	67.49	1800	1802	1801	2201	2220	2211
F_1	13.85	14.63	14.24	76.00	74.65	75.33	2038	1992	2015	2494	2438	2466
F_2	16.15	16.43	16.29	79.13	78.62	78.88	2280	2294	2287	2807	2734	2771
F_3	17.25	17.55	17.40	84.10	83.87	83.98	2503	2483	2493	3023	2980	3001
S. Em.+	0.36	0.35	0.25	1.20	1.41	0.92	45	43	31	69	70	49
C.D. (P= 0.05)	1.03	1.00	0.70	3.45	4.06	2.61	131	123	88	199	203	139
Biofertilizers (B)												
B_0	14.28	14.03	14.16	72.81	72.57	72.69	2008	1976	1992	2498	2400	2449
B_1	16.13	16.53	16.33	80.56	79.74	80.15	2302	2309	2306	2764	2786	2775
S.Em.+	0.26	0.24	0.18	0.85	0.99	0.65	32	30	22	49	50	35
C.D. (P= 0.05)	0.74	0.71	0.50	2.44	2.87	1.85	93	87	62	141	143	98
Micronutrients (M)												
M_0	14.33	14.30	14.32	73.13	73.33	73.23	2101	2064	2083	2535	2510	2523
M_1	15.52	16.26	15.89	80.24	78.98	79.61	2210	2222	2216	2728	2676	2702
S.Em.+	0.25	0.24	0.18	0.85	0.99	0.65	32	30	22	49	50	35
C.D. (P= 0.05)	0.73	0.71	0.50	2.44	2.87	1.85	93	87	62	141	143	98
Interaction												
F × B × M	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.
C.V.%	8.26	7.84	8.05	5.40	6.40	5.92	7.30	6.90	7.10	9.10	9.38	9.23

(2007).

Effect of biofertilizers

Various growth parameters except plant height recorded at 30 DAS were significantly affected by biofertilizers application. Significantly higher plant height at 60 DAS i.e., 35.33 cm, 35.61 cm and 35.47 cm and plant height at harvest i.e., 54.33 cm, 54.74 cm and 54.54 cm as well as number of branches plant^{-1}i.e., 11.28, 11.65 and 11.46 recorded during 2013-14, 2014-15 and in pooled analysis, respectively due to biofertilizers treatment B_1 (PSB + Rhizobium @ 5 ml kg^{-1} seed each) over B_0 (Control) (Table 1). This might be due to the inoculation of biofertilizers benefited the plant by providing atmospheric nitrogen and rendering the insoluble phosphorus into the available form. The enhanced availability of phosphorus favored nitrogen fixation and rate of photosynthesis and consequently led to better plant growth. Present results are in agreement with those reported by Tagore *et al* (2013).

Biofertilizers treatment B_1 (PSB + Rhizobium @ 5 ml kg^{-1} seed each) exerted significant influence and recorded higher number of nodules plant^{-1} i.e., 16.13, 16.53 and 16.33 during the years 2013-14, 2014-15 and in pooled analysis, respectively (Table 2). The increase in nodulation might be due to the role of Rhizobium inoculation in biological nitrogen fixation and also due to the fact that phosphate solubilizing bacteria by virtue of their property of producing organic acids, solubilize insoluble or fixed form of phosphorus in the rhizosphere and make it available to the growing plants, which promotes root development and thereby nodulation in the plants. Similar findings were reported by Singh *et al* (2011).

Biofertilizers treatment B_1 (PSB + Rhizobium @ 5 ml kg^{-1} seed each) had significant influence on number of pods plant^{-1} i.e., 80.56, 79.74 and 80.15 during the years 2013-14, 2014-15 and in pooled analysis, respectively as compared to control (Table 2).

Table 3: Number of nodules plant-1 , number of pods plant-1 , seed yield and straw yield as influenced by F x B x M interaction

Treatments	Number of nodules plant $^{-1}$				Number of pods plant $^{-1}$				Seed yield (kg ha $^{-1}$)				Straw yield (kg ha^{-1})			
	B_0		B_1		B_0		B_1		B_0		B_1		B_0		B_1	
	M_0	M_1	M_0	M_1	M_0	M_1	M_0	M_1	M_0	M_1	M_0	M_1	M_0	M_1	M_0	M_1
	2013-14				**2013-14**				**2013-14**				**2013-14**			
F_0	9.53	14.00	11.60	14.67	55.87	66.60	73.20	74.33	1633	1870	1907	1790	2071	2374	2281	2080
F_1	12.27	14.07	15.60	13.47	72.80	77.07	73.80	80.33	1886	1997	2185	2084	2250	2477	2634	2617
F_2	16.13	15.87	14.40	18.20	72.27	76.33	76.53	91.40	2040	1978	2339	2763	2547	2509	2859	3314
F_3	15.67	17.13	16.93	19.27	80.33	81.20	80.20	94.67	2318	2345	2500	2849	2777	2983	2863	3469
S.Em. +	0.71				2.39				91				138			
C.D. (P= 0.05)	2.01				6.77				257				391			
C.V.%	8.26				5.40				7.30				9.10			
	2014-15				**2014-15**				**2014-15**				**2014-15**			
F_0	9.53	13.47	11.80	15.20	56.60	66.73	73.47	73.13	1572	1866	1851	1919	2017	2360	2305	2199
F_1	12.40	15.80	16.07	14.27	72.67	76.73	74.33	74.87	1821	1935	2158	2055	2164	2419	2654	2515
F_2	14.20	17.00	15.07	19.47	72.87	74.07	77.20	90.33	2014	2037	2309	2817	2398	2405	2806	3326
F_3	15.47	16.53	17.73	20.47	78.00	82.87	81.53	93.07	2262	2305	2528	2838	2704	2734	3033	3448
S.Em. +	0.69				2.81				85				140			
C.D. (P= 0.05)	1.96				7.96				241				397			
C.V.%	7.84				6.40				6.90				9.38			
	Pooled				**Pooled**				**Pooled**				**Pooled**			
F_0	9.53	13.73	11.70	14.93	56.23	66.67	73.33	73.73	1602	1868	1879	1854	2044	2367	2293	2140
F_1	12.33	14.93	15.83	13.87	72.73	76.90	74.07	77.60	1853	1966	2172	2069	2207	2448	2644	2566
F_2	15.17	16.43	14.73	18.83	72.57	75.20	76.87	90.87	2027	2008	2324	2790	2473	2457	2832	3320
F_3	15.57	16.83	17.33	19.87	79.17	82.03	80.87	93.87	2290	2325	2514	2844	2741	2859	2948	3458
S.Em. +	0.50				1.85				62				98			
C.D. (P= 0.05)	1.40				5.22				176				279			
C.V.%	8.05				5.92				7.10				9.23			

Table 4: Green fodder yield, dry fodder yield and crude protein content of succeeding fodder sorghum as influenced by residual effect of fertilizer levels, biofertilizers and micronutrients

Treatments	Green fodder yield (q ha^{-1})			Dry fodder yield (q ha^{-1})			Crude protein content (%)		
	2013-14	2014-15	Pooled	2013-14	2014-15	Pooled	2013-14	2014-15	Pooled
Fertilizer levels (F)									
F_0	259	271	265	89	92	91	5.17	5.21	5.19
F_1	283	291	287	92	97	94	5.36	5.45	5.41
F_2	284	296	290	96	99	97	5.42	5.46	5.44
F_3	310	319	315	105	107	106	6.02	5.98	6.00
S. Em.+	7.35	7.57	5.28	2.56	2.30	1.72	0.12	0.13	0.09
C.D. (P= 0.05)	21.23	21.88	14.93	7.39	6.65	4.87	0.34	0.37	0.25
Biofertilizers (B)									
B_0	281	289	285	94	97	95	5.50	5.53	5.52
B_1	287	299	293	97	100	99	5.48	5.52	5.50
S.Em.+	5.20	5.36	3.73	1.81	1.63	1.22	0.08	0.09	0.06
C.D. (P= 0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS
Micronutrients (M)									
M_0	279	289	284	94	97	96	5.46	5.49	5.48
M_1	289	299	294	97	100	99	5.52	5.56	5.54
S.Em.+	5.20	5.36	3.73	1.81	1.63	1.22	0.08	0.09	0.06
C.D. (P= 0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS
Interactions									
F × B × M	NS	NS	NS	NS	NS	NS	NS	NS	NS
C.V.%	8.97	8.92	8.94	9.28	8.09	8.69	7.37	8.08	7.74

This might be due to the fact that Rhizobium inoculation increased the root nodulation through better root development and more nutrient availability. This caused vigorous plant growth and dry matter production, which resulted in better flowering and pod formation. This results are in accordance with that of Meena *et al* (2015). Crop sown with biofertilizers treatment B_1 (PSB + Rhizobium @ 5 ml kg^{-1} seed each) recorded significantly higher seed yield i.e., 2302, 2309 and 2306 kg ha^{-1} and straw yields of chickpea i.e., 2764, 2786 and 2775 kg ha^{-1} during 2013-14, 2014-15 and on pooled basis, respectively than treatment B_0 (Control) (Table 2). Biofertilizers treatment increase the growth and yield attributes like plant height, number of branches plant^{-1}, number of nodules plant^{-1} and number of pods plant^{-1} which ultimately increased the seed and straw yields. This could be because biofertilizer inoculation helped the plant by providing atmospheric nitrogen and converting insoluble phosphorus to usable form. Increased phosphorus availability favoured nitrogen fixation and photosynthetic rate, resulting in improved plant growth. Shukla *et al* (2013) and Kumar *et al* (2015) both reported similar findings. The residual effect of inoculation of chickpea seed with biofertilizers (PSB + Rhizobium @ 5 ml kg^{-1} seed each) failed to notice significant variation in green fodder yield, dry fodder yield and crude protein content of succeeding fodder sorghum during both the years and on pooled basis. This might be due to fodder sorghum being a high responsive crop to the applied nutrients and alone application of biofertilizers to preceding chickpea crop and their residual effects might not reach to the level of significance. Similar findings were reported by Chaudhari (2011).

Effect of micronutrients

Growth characters like number of branches plant^{-1} and number of nodules plant^{-1} significantly influenced due to application of Micronutrient mixture grade-V, whereas, plant height was not significantly influenced due to micronutrients treatment. Treatment M_1 (Micronutrient mixture grade-V @ 20 kg ha^{-1}) produced significantly more number of branches plant^{-1} i.e., 11.09, 11.43 and 11.26 and number of nodules plant^{-1} i.e., 15.52, 16.26 and 15.89 during the years 2013-14, 2014-15 and on pooled basis, respectively as compared to untreated control (M_0) (Tables 1 and 2).

The micronutrients application M_1 (Micronutrient mixture grade-V @ 20 kg ha^{-1}) had significant influence on number of pod plant^{-1} i.e., 80.24, 78.98 and 79.61 during the years 2013-14, 2014-15 and on pooled basis, respectively as compared to M_0 (Control) (Table-2). Crop sown with treatment M_1 (Micronutrient mixture grade-V @ 20 kg ha^{-1}) recorded significantly higher seed yield i.e., 2210, 2222 and 2216 kg ha^{-1} and straw yield of chickpea i.e., 2728, 2676 and 2702 kg ha^{-1}during the years 2013-14, 2014-15 and in pooled analysis, respectively over no application of micronutrient (M_0) (Table 2). This could be attributed to the favourable effects of multi-micronutrients, which offer balanced nutrition to plants, resulting in enhanced crop development and yield. Supplementing multi micronutrients during the growth period of the crops supplied balanced nutrition to the plants, resulting in higher agricultural yields. Also, the addition of the micronutrients helps in better utilization of the major nutrients to produce higher yield of the crops. The hidden deficiencies of micronutrients are overcome due to their supplementation during the growth period, which results in better crop growth and thereby yield. These findings are in conformity with the Patel and Singh (2010), Bejandi *et al* (2012) and Singh *et al* (2015).

The residual effect of micronutrients on the green fodder yield, dry fodder yield and crude protein content of the succeeding fodder sorghum crop were found non-significant during both the years as well as on pooled basis.

Interaction effects

Number of nodules plant^{-1}, number of pods plant^{-1} as well as seed and straw yields were significantly influenced by interactions of different fertilizer levels, biofertilizers and micronutrients treatment i.e., F x B x M. While, plant height and number of branches plant^{-1} were not influenced by different treatment combinations.

Significantly the highest number of nodules plant^{-1} i.e.,19.27,20.47 and 19.87 as well as number of pods plant^{-1}i.e., 94.67,93.07 and 93.87 during the years 2013-14, 2014-15 and in pooled results respectively were recorded under treatment combination $F_3B_1M_1$ which was remained statistically at par with treatment combination $F_2B_1M_1$. Same trend was observed in respect to seed and straw yield of chickpea. Significantly the highest seed yield i.e., 2849, 2838 and 2844 kg ha^{-1} and straw yield i.e., 3469, 3448 and 3458 kg ha^{-1} during the years 2013-14, 2014-15 and in pooled results respectively were recorded under treatment combination $F_3B_1M_1$ which was remained statistically at par with treatment combination $F_2B_1M_1$ (Table 3). This might be attributed to the application of fertilizer with Rhizobium + PSB might have favoured the soil organic carbon enrichment, microbial activity and mineral nutrition in crops which resulted in better plant height, number of branches and nodulation at various stages of crop growth. Further, the positive effect of micronutrient mixture grade-V @ 20 kg ha^{-1} along with Rhizobium + PSB inoculation on these parameters might be due to the role of these micronutrients in many physiological and energy related processes in plant system. The supplementation of multi-micronutrients along with recommended dose of fertilizer provide balanced nutrition to the crops for improvement in crops yields. Also, the addition of the micronutrients helps in better utilization of the major nutrients to produce higher yield of the crops. The results of similar kind in chickpea have also been reported by Shukla *et al* (2013), Kumar *et al* (2015), Tomar (2016) and Verma *et al* (2017).

Residual effect of interaction among fertilizer levels, biofertilizers and micronutrients were found non-significant for green fodder yield, dry fodder yield and crude protein content of succeeding fodder sorghum during 2013-14, 2014-15 and in pooled results.

CONCLUSION

On the basis of results of two years of field experiment, it can be concluded that in loamy sand soil of middle Gujarat, integrated nutrient management practices involving 75 % RDF (18.75 + 37.5 NP, kg ha^{-1}) + (PSB and Rhizobium @ 5 ml kg^{-1} seed each) + Micronutrient mixture grade-V @ 20 kg ha^{-1} (soil application) in chickpea and 50 % RDF (40-20 NP, kg ha^{-1}) in fodder sorghum gave better results in respect of growth, yield attributes and yield in the chickpea-fodder sorghum cropping sequence.

REFERENCES

Anonymous 2020. Agricultural Statistics at Glance. Department of Agriculture and Co-operation, Ministry of Agriculture, Govt. of India (New Delhi) .

Bejandi TK, Sharifi RS, Sedghi M and Namvar A. 2012. Effects of plant density, rhizobium inoculation and micro elements on nodulation, chlorophyll content and yield of chickpea (Cicer arietinum L.). *Ann. Biol. Res* **3**(2):951-958.

Chaudhari PM 2011. Influence of phosphorus management treatments, sulphur and biofertilizers on growth and yield of fenugreek (Trigonella foenum-graecum) and their residual effect on yield of succeeding pearl millet crop (Anand) .

Chaudhari RK, Patel TD, Patel JB and Patel RH. 1998. Response of chickpea cultivars to irrigation, nitrogen and phosphorus on sandy clay loam soil. *Int. Chickpea -Pegionpea News Letter* **5**:24-26.

Das S, Pareek BL, Kumawat A and Dhikwal SR. 2013. Effect of phosphorus and biofertilizers on productivity of chickpea (Cicer arietinum L.) in north western Rajasthan. *India. Legume Res* **36**(6):511-514.

Dewangan S, Singh RJ, Singh S and Singh MK. 2017. Effect of integrated nutrients management and drought mitigating strategies on yield, water use efficiency and soil fertility of rainfed chickpea. *Cicer arietinum L.). Indian J. Agric. Sci* **87**(2):245-50.

Kumar D, Arvadiya LK, Desai KL, Usadadiya VP and Patel AM. 2015. Growth and yield of chickpea (Cicer arietinum L.) as influenced by graded levels of fertilizers and biofertilizers. . *The Bioscan* **10**(1):335-338.

Meena JS, Verma HP and Pancholi P. 2015. Effect of fertility levels and biofertilizers on growth and yield of cowpea on sandy loam soil of Rajasthan. *An Asian J. Soil Sci* **10**(1):55-58.

Pankhaniya RM 2007. Integrated nutrient management in summer soybean [Glycine max. (L.) Merril] - kharif fodder sorghum [Sorghum bicolor (L.) Moench] sequence under south Gujarat conditions (Navsari) .

Patel KP and Singh MV 2010. 19th world congress of soil science. 129-132.

Shukla A, Sharma RD, Rajput S, Pandey G and Marko GS. 2013. Effect of foliar and basal nourishment on chlorophyll content, yield, quality and economics of chickpea. *Cicer arietinum L.). Crop Res* **46**(1):63-65.

Singh DK, Singh AK, Singh SK, Singh M and Srivastava OP. 2015. Effect of balanced nutrition on yield and nutrient uptake of pea (Pisum sativum L.) under Indo-Gangetic plains of India. The Bioscan, An Int. *Quarterly J. Life sci* **10**(3):1245-1294.

Singh G, Sekhon HS and Sharma P. 2011. Effect of irrigation and biofertilizer on water use, nodulation, growth and yield of chickpea. *Cicer arietinum L.). Archives Agron. and Soil Sci* **57**(7):715-726.

Tagore GS, Namdeo SL, Sharma SK and Kumar N. 2013. Effect of rhizobium and phosphate solubilizing bacterial inoculants on symbiotic traits, nodule, leghemoglobin and yield of chickpea genotypes. *Int. J.Agron., Article ID* **581627**:1-8.

Tomar M 2016. Effect of micronutrients, biofertilizers and FYM on nodulation, nutrients uptake and yield of chickpea in Vertisol. Part of M.Sc. (Agri.) thesis submitted to the RVSKVV (Gwalior) .

Tripathi LK, Thomas T and Kumar S. 2013. Impact of nitrogen and phosphorus on growth and yield of chickpea (Cicer arietinum L.). *An Asian J. Soil Sci* **8**(2):260-263.

Verma NK, Pandey BK, Mahan RD and Kumar A. 2017. Response of mode of application with integrated nutrient management on growth and yield of chick pea (Cicer arietinum L.). *Int.J. Agric. Innov. and Res* **6**(1):2319-1473.

Citation:

Chaudhari JH, Sadhu AC, Sonani VV and Chauhan SA. 2022. Chickpea Performance as Influenced by Nutrient Management and their Residual Effects on succeeding Fodder Sorghum. *Journal of AgriSearch* **9**(1): 29-36