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Effect on seed yield and quality characteristics of chickpea as influenced by integrated nutrient management in chickpea-fodder maize cropping sequence

HA Patel and JD Thanki

Abstract
The investigation was conducted during *rabi* and summer seasons of 2017-18 and 2018-19 at college farm of N. M. College of Agriculture, Navsari Agricultural University, Navsari to study Effect on seed yield and quality characteristics of chickpea as influenced by integrated nutrient management in chickpea- fodder maize cropping sequence. The field experiment consisted of integrated nutrient management *viz*., T_1 - 100% RDF, T_2 - 75% RDF, T_3 - 100% RDF + *Rhizobium* + PSB, T_4 - 75% RDF + *Rhizobium* + PSB, T_5 - control to chickpea in *rabi* season replicated four times in randomized block design. Treatment 100% RDF + *Rhizobium* + PSB (T_3) recorded all most significantly higher seed yield, nutrient content, uptake and protein content as well as protein yield being remained at par with application of 100% RDF (T_1) and 75% RDF + *Rhizobium* + PSB (T_4) during both the years and in pooled analysis.

Keywords: Seed yield, *Rhizobium*, Nutrient content, uptake and protein yield

Introduction

Increasing agricultural productivity is a key challenge in realising higher output and farmers' income. The green revolution endowed India with a greater genetic diversity. In India, total food grain production 291.95 million/tonnes. Gujarat has geographical area of 19.6 million hectares, out of which, 55.10% is under agriculture land *i.e*. 10.8 million hectares (Anonymous, 2019) [3].

The most important reason for the emergence of agrarian distress in the country during 1990s is the low level of absolute income as well as large and deteriorating disparity between income of a farmer and non-agricultural worker, which turned even more serious in latest years. The Hon'ble Prime Minister, goal set to double farmers' income by 2022 can play crucial role to promote farmer's welfare, reduce agrarian distress and bring parity between income of farmers and those working in non-agricultural professions. Therefore, strong measures are actually needed to harness all possible sources of growth in farmers. The major sources of growth operating within agriculture sector may be improvement in productivity, resource use efficiency or saving in cost of production, increase in cropping intensity and diversification towards high value crops (Khanam *et al*. 2018) [7].

Cropping system approach has gained importance in agriculture and relative enterprises. A system consists of several components which are closely related to interacting among themselves. Such a package of management practices for all the crops leads to efficient use of costly inputs, besides reduction in production cost. For instants, residual effect of fertilizers applied and nitrogen fix by legumes can considerably bring down the production cost, if all the crops are considered when individual crops. In this context, cropping system approaches gaining importance.

Chickpea (*Cicer arietinum* L.) commonly known as Bengal gram and locally *chana*. It is a good source of vitamins such as riboflavin, niacin, thiamin, folate, A precursor, β-carotene and the protein quality is considered to be better than other pulses. Starch is the major storage carbohydrate followed by dietary fiber, oligosaccharides and simple sugars like glucose and sucrose. Chickpea is rich in nutritionally important unsaturated fatty acids like linoleic and oleic acid. In India, chickpea is grown in an area of 10.56 million hectares with total production of 11.23 million tonnes with productivity of 1063 kg/ha.

While in Gujarat, chickpea is grown in an area of 0.29 million hectares producing 0.37 million tonnes with the productivity of 1253 kg/ha (Anonymous, 2018) [2].

Nutrient management is another important agronomic practice which greatly affects productivity and profitability of the cropping system, but in recent past due to increased cropping intensity, imbalance in nutrient application and increased reliance on inorganic fertilizers alone, the productivity of soils has gone down. Role of the balanced use of inorganic fertilizer and biofertilizers in improving soil fertility and sustainability of the cropping system is well documented. The low production of this crop is due to improper use of fertilizers and least importance given to biofertilizers such as *Rhizobium* and PSB. The increasing demand for production of crops and food for such a vast population has led to an interest and necessity for the use of bio-fertilizers for the betterment of these crops and even for the health of the soil. Biofertilizers can be a very good complimentary to fertilizers. Fertilizers like nitrogen and phosphorus are the most important elements as well as expensive inputs in crop production. An adequate supply of chemical fertilizers is closely associated with growth and development of plant. *Rhizobium* inoculation can increase the grain yield of pulse crops to the tune of 10 to 15% (Ali and Chandra, 1985) [1]. Phosphate solubilizing bacteria (PSB) have the consistent capacity to increase the availability of phosphates to plants by mineralizing organic phosphorus compounds. For improving the overall productivity and stability of chickpea based food-fodder cropping system proper management of critical inputs is necessary.

Materials and Methods

The present study was carried out by laying out a field experiment on chickpea with levels of recommended dose of fertilizer in combination with *Rhizobium*, PSB, application of farm yard manure in *rabi* season and levels of recommended dose of fertilizer to fodder maize in summer season during 2017-18 and 2018-19 for two consecutive years on same site without changing the randomization. The soil of experimental field was clay in texture and low in nitrogen (196.80 kg/ha), medium in phosphorus (38.30 kg/ha), high in potassium (315.43 kg/ha) and slightly alkaline in reaction (pH 8.23). The T_1 - 100% RDF (20 N + 40 P_2O_5 + 00 K_2O kg/ha), T_2 - 75% RDF, T_3 - 100% RDF + *Rhizobium* + PSB, T_4 - 75% RDF + *Rhizobium* + PSB, T_5 - control and general application of FYM 2.5 t/ha to chickpea in *rabi* season replicated four times in randomized block design. During summer season each main plot treatment was split into four sub plot treatments with four levels of RDF *viz*., S_1 - 100% RDF (80 N + 40 P_2O_5 + 00 K_2O kg/ha), S_2 - 75% RDF, S_3 - 50% RDF and S_4 - control to fodder maize resulting in twenty treatment combinations replicated four times in split plot design. Chickpea variety GG-2 was used for the sowing. Sowing was done manually in 3 cm depth previously opened small furrows at 30 cm apart using seed rate of 60 kg/ha on 14th November in 2017 and 19th November in 2018.

Result and Discussion

Effect of integrated nutrient management in chickpea

Yield parameters: Application 100% RDF + *Rhizobium* + PSB (T3) recorded significantly higher seed yield (Table 1) (23.22, 23.73 and 23.47 q/ha) being remained at par with application of 100% RDF (T1) (22.13, 22.28 and 22.20 q/ha) and 75% RDF + *Rhizobium* + PSB (T4) (21.73, 21.78 and 21.75 q/ha). Moreover, significantly lowest seed yield (17.37, 18.17 and 17.77 q/ha) was recorded control (T5) during both the years of study and in pooled results. The response was in the order of T3>T1>T4>T2>T5. The increase in seed yield was 32.08, 24.93, 22.40 and 11.03% higher with treatments T3, T1, T4 and T2 over T5, respectively on the basis of pooled data. Significantly higher stover yield (42.71, 42.80 and 42.76 q/ha) was recorded with the application of 100% RDF + *Rhizobium* + PSB (T3) and remained at par with application of 100% RDF (T1) (41.65, 41.69 and 41.67 q/ha) and 75% RDF + *Rhizobium* + PSB (T4) (41.42, 41.38 and 41.40 q/ha) during both the years and in pooled analysis. Whereas treatment control (T5) gave significantly lowest stover yield (36.68, 36.80 and 36.74 q/ha) during individual years and in pooled analysis, respectively. The per cent increase in stover yield of chickpea under treatment order in T3>T1>T4>T2>T5 was found to the tune of 16.39, 13.42, 12.68 and 8.55%, respectively over treatment control (T5) on the basis of pooled data. Seed yield, the ultimate result of various interacting growth factors and yield contributing characters increased consistently and significantly with application of inorganic fertilizer as well as combination of inorganic fertilizer with biofertilizers. It may also be due to adequate availability of major nutrients which are required in larger quantity thus directly help the plants to register higher yield. An increase in the seed yield with general application of FYM served as reserves of macro and micro nutrients which are released during process of mineralization. Almost similar findings were also reported by Poonia and Pithia (2014) [10] Kumar *et al*. (2015) [8] and Singh *et al*. (2017) [11].

Table 1: Seed and stover yields and harvest index of chickpea as influenced by different treatments

Treatment	Seed yield (q/ha)			Stover yield (q/ha)			Harvest index (%)		
	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled
T_1: 100% RDF	22.13	22.28	22.20	41.65	41.69	41.67	34.64	34.80	34.72
T_2: 75% RDF	19.64	19.81	19.73	39.84	39.92	39.88	33.03	33.16	33.09
T_3: 100% RDF + *Rhizobium* + PSB	23.22	23.73	23.47	42.71	42.80	42.76	35.16	35.64	35.40
T_4: 75% RDF + *Rhizobium* + PSB	21.73	21.78	21.75	41.42	41.38	41.40	34.42	34.48	34.45
T_5: Control	17.37	18.17	17.77	36.68	36.80	36.74	31.73	32.75	32.24
S.Em+	1.15	1.09	0.79	0.65	0.66	0.46	1.51	1.35	1.01
CD (P=0.05)	3.54	3.36	2.33	2.00	2.04	1.36	NS	NS	NS
CV (%)	11.03	10.30	10.66	3.21	3.27	3.24	8.91	7.88	8.41
General mean	20.82	21.15	20.99	40.46	40.52	40.49	33.80	34.17	33.98
Interaction (Y x T)									
S.Em+	1.12			0.66			1.43		
CD (P=0.05)	NS			NS			NS		

Table 2: Nutrient (N, P_2O_5 and K_2O) content of chickpea seed as influenced by different treatments

Treatment	Nitrogen content (%)			P_2O_5 content (%)			K_2O content (%)		
	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled
T_1: 100% RDF	3.65	3.69	3.67	0.314	0.316	0.315	1.401	1.400	1.401
T_2: 75% RDF	3.24	3.32	3.28	0.281	0.282	0.282	1.360	1.359	1.360
T_3: 100% RDF + *Rhizobium* + PSB	3.72	3.79	3.75	0.322	0.334	0.328	1.501	1.408	1.455
T_4: 75% RDF + *Rhizobium* + PSB	3.46	3.54	3.50	0.302	0.308	0.305	1.396	1.342	1.369
T_5: Control	3.05	3.07	3.06	0.272	0.275	0.274	1.296	1.316	1.306
S.Em+	0.07	0.08	0.05	0.006	0.006	0.004	0.048	0.044	0.033
CD (P=0.05)	0.22	0.26	0.16	0.017	0.018	0.012	NS	NS	NS
CV (%)	4.13	4.78	4.47	3.800	3.815	3.810	6.892	6.497	6.700
General mean	3.42	3.48	3.45	0.298	0.303	0.301	1.391	1.365	1.378
Interaction (Y x T)									
S.Em+	0.08			0.006			0.046		
CD (P=0.05)	NS			NS			NS		

Table 3: Nutrient (N, P_2O_5 and K_2O) content of chickpea stover as influenced by different treatments

Treatment	Nitrogen content (%)			P_2O_5 content (%)			K_2O content (%)		
	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled
T_1: 100% RDF	1.09	1.10	1.10	0.206	0.204	0.205	2.297	2.334	2.316
T_2: 75% RDF	1.06	1.08	1.07	0.181	0.183	0.182	2.259	2.274	2.267
T_3: 100% RDF + *Rhizobium* + PSB	1.13	1.12	1.12	0.212	0.206	0.209	2.328	2.346	2.337
T_4: 75% RDF + *Rhizobium* + PSB	1.08	1.09	1.09	0.201	0.199	0.200	2.280	2.290	2.285
T_5: Control	0.88	0.88	0.88	0.178	0.180	0.179	2.207	2.211	2.209
S.Em+	0.02	0.02	0.01	0.005	0.004	0.003	0.040	0.043	0.029
CD (P=0.05)	0.06	0.06	0.04	0.015	0.011	0.009	NS	NS	NS
CV (%)	3.51	3.65	3.58	4.887	3.701	4.340	3.494	3.778	3.640
General mean	1.05	1.06	1.05	0.196	0.194	0.195	2.274	2.291	2.283
Interaction (Y x T)									
S.Em+	0.02			0.004			0.042		
CD (P=0.05)	NS			NS			NS		

Table 4: Total (N, P_2O_5 and K_2O) uptake by chickpea (seed and stover) as influenced by different treatments

Treatment	Nitrogen uptake (kg/ha)			P_2O_5 uptake (kg/ha)			K_2O uptake (kg/ha)		
	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled
T_1: 100% RDF	126.29	128.19	127.24	15.54	15.56	15.55	126.60	128.52	127.56
T_2: 75% RDF	105.92	109.13	107.53	12.73	12.90	12.81	116.70	117.81	117.25
T_3: 100% RDF + *Rhizobium* + PSB	134.18	138.01	136.09	16.52	16.74	16.63	134.13	133.81	133.97
T_4: 75% RDF + *Rhizobium* + PSB	119.97	122.26	121.12	14.90	14.93	14.92	124.60	124.00	124.30
T_5: Control	85.05	87.89	86.47	11.23	11.60	11.41	103.40	105.68	104.54
S.Em+	3.78	4.72	3.02	0.48	0.45	0.33	2.01	2.73	1.70
CD (P=0.05)	11.65	14.55	8.90	1.47	1.38	0.96	6.19	8.41	4.99
CV (%)	6.61	8.07	7.39	6.74	6.25	6.50	3.32	4.48	3.95
General mean	114.28	117.10	115.69	14.18	14.34	14.26	121.09	121.96	121.52
Interaction (Y x T)									
S.Em+	4.28			0.46			2.40		
CD (P=0.05)	NS			NS			NS		

Nutrient content and uptake

It is evident from the data presented in During first and second years and in pooled results, chickpea seed (Table 2) registered significantly higher nitrogen content with the application of 100% RDF + *Rhizobium* + PSB (T_3) and remained at par with application of 100% RDF (T_1) whereas second year it was at par with 75% RDF + *Rhizobium* + PSB (T_4). Significantly higher nitrogen content in chickpea stover (Table 3) was recorded with the 100% RDF + *Rhizobium* + PSB (T_3) but it found at par with application of 100% RDF (T_1) and 75% RDF + *Rhizobium* + PSB (T_4).

Chickpea seed recorded significantly higher phosphorus content with the treatment 100% RDF + *Rhizobium* + PSB (T_3) being at par with treatment 100% RDF (T_1) during 2017-18. Moreover, significantly highest phosphorus content in seed was noted under treatment 100% RDF + *Rhizobium* + PSB (T_3) during 2018-19 and pooled. Application of 100% RDF + *Rhizobium* + PSB (T_3) to chickpea was registered significantly higher phosphorus content in chickpea stover and remained at par with application of 100% RDF (T_1) and 75% RDF + *Rhizobium* + PSB (T_4) during 2017-18 and 2018-19 and in pooled analysis. The results of present study are in agreement with those reported by Kumar *et al.* (2015) [8] and Chaudhari (2019) [4].

Application of 100% RDF + *Rhizobium* + PSB (T_3) registered significantly higher total nitrogen uptake by seed and stover (Table 4) but it was at par with 100% RDF (T_1) during individual year of study and in pooled analysis. Application of 100% RDF + *Rhizobium* + PSB (T_3) recorded significantly higher total phosphorus uptake by seed and stover but remained at par with treatment 100% RDF (T_1) during first and second years of investigation, while in pooled analysis, highest total phosphorus uptake by seed and stover was recorded under treatment 100% RDF + *Rhizobium* + PSB (T_3).

During first and in pooled analysis, highest total potassium uptake by seed and stover was recorded with application of 100% RDF + *Rhizobium* + PSB (T_3). Whereas in second year, significantly higher total potassium uptake by seed and stover was noted under application of 100% RDF + *Rhizobium* + PSB (T_3) being remained at par with treatment 100% RDF (T_1). Similar results were reported by Duhan (2013) [6], Dixit *et al*. (2015) [5], Kumar *et al*. (2015) [8] and Chaudhari (2019) [4].

Protein content and protein yield

Protein content (Table 5) in chickpea was found significantly differ and higher protein content was recorded with application of 100% RDF + *Rhizobium* + PSB (T_3) which was at par with 100% RDF (T_1) during both years of study and in pooled result. Whereas second year, it was remained at par with 75% RDF + *Rhizobium* + PSB (T_4). Significantly higher protein yield was noted under the treatment 100% RDF + *Rhizobium* + PSB (T_3) being at par with treatment 100% RDF (T_1) and 75% RDF + *Rhizobium* + PSB (T_4) during first year. However, it was remained at par with application of 100% RDF (T_1) during second year and in pooled result. The increased in protein content and protein yield may be due to more uptake of nutrient with combine application of nutrient sources. The results are also supported by Dixit *et al*. (2015) [5] and Kumar *et al*. (2018) [9].

Table 5: Protein content and protein yield of chickpea seed as influenced by different treatments

Treatment	Protein content (%)			Protein yield (q/ha)		
	2017-18	**2018-19**	**Pooled**	**2017-18**	**2018-19**	**Pooled**
T_1: 100% RDF	22.81	23.06	22.94	5.06	5.14	5.10
T_2: 75% RDF	20.25	20.75	20.50	3.98	4.12	4.05
T_3: 100% RDF + *Rhizobium* + PSB	23.23	23.69	23.46	5.38	5.63	5.50
T_4: 75% RDF + *Rhizobium* + PSB	21.63	22.13	21.88	4.70	4.82	4.76
T_5: Control	19.06	19.18	19.12	3.31	3.47	3.39
S.Em+	0.44	0.52	0.34	0.24	0.26	0.17
CD (P=0.05)	1.36	1.60	1.00	0.73	0.79	0.51
CV (%)	4.13	4.78	4.47	10.51	11.12	10.83
General mean	21.40	21.76	21.58	4.48	4.64	4.56
Interaction (Y x T)						
S.Em+	0.48			0.25		
CD (P=0.05)	NS			NS		

Conclusion

Getting higher yield, maintenance of nutrient status and increased protein yield of chickpea crop should be nourished with 75% RDF (15 N + 30 P_2O_5 + 00 K_2O kg/ha) + *Rhizobium* (10 ml/kg seed) + PSB (10 ml/kg seed) with 2.5 t/ha FYM in chickpea- fodder maize cropping sequence in south Gujarat condition.

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