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Influence of fertilizer levels and thiourea application on quality, nutrient uptake and economics of chickpea (*Cicer arietinum* L.)

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Abstract
A field experiment was conducted at Agronomy Instructional Farm, Chimanbhai Patel College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar, Dantiwada, Gujarat during the *rabi* season of the year 2022-23 on "Influence of Fertilizer Levels and Thiourea Application on Quality, Nutrient Uptake and Economics of Chickpea (*Cicer arietinum* L.)". The soil of the experimental plot was loamy sand in texture, low in organic carbon, available nitrogen and medium in available phosphorus and high in available potassium. The experiment comprised of twelve treatments viz., T_1: 50 % RDF, T_2: 75 % RDF, T_3: 100 % RDF, T_4: 50 % RDF + 500 ppm thiourea at branching, T_5: 50 % RDF + 500 ppm thiourea at pre-flowering, T_6: 50% RDF + 500 ppm thiourea at branching and pre-flowering, T_7: 75 % RDF + 500 ppm thiourea at branching, T_8: 75 % RDF + 500 ppm thiourea at pre-flowering, T_9: 75 % RDF + 500 ppm thiourea at branching and pre-flowering, T_{10}: 100 % RDF + 500 ppm thiourea at branching, T_{11}: 100 % RDF + 500 ppm thiourea at pre-flowering and T_{12}: 100 % RDF + 500 ppm thiourea at branching and pre-flowering were evaluated in randomized block design replicating three times. Significantly higher protein content (19.75%), protein yield (412.21 kg/ha) and nitrogen and phosphorus uptake by seed and stover (65.94 kg/ha and 44.40 kg/ha and 9.60 and 7.11 kg/ha, respectively.) were recorded under treatment T_{12}, which received 100% RDF along with 500 ppm thiourea spray at branching and pre-flowering stages. The performance of T_{12} was found to be at par with T_9, T_{10} and T_{11}. The highest net realization (69915 ₹/ha) was obtained under treatment T_{12} (100% RDF along with 500 ppm thiourea spray at branching and pre-flowering), with a benefit: cost ratio (BCR) of 2.83.

Keywords: Chickpea, RDF, thiourea, branching, pre-flowering

Introduction

Pulse crops play an important role in Indian agriculture and India is the largest producer and consumer of pulses in the world. Currently, the higher population growth and low protein content of cereals has attracted the attention of people to pulses consumption as an important source of required protein (Bateni, 1983) [1]. Among the pulses, chickpea (*Cicer arietinum* L.) is the second important pulse crop in the world after dry beans. Chickpea is a good source of energy, protein, minerals (especially potassium, phosphorus, calcium, magnesium, copper, iron and zinc), vitamins (especially vitamin B), fiber and also contains potentially health beneficial phytochemicals. The protein concentration of chickpea seed ranges from 18.0 to 22.0% for desi type and 12.6 to 29.0% for kabuli type, which is commonly 2 to 3 times higher than that of cereal grains. Chickpea exhibits higher lipid content than other pulses. Carbohydrates are the major nutritional component in chickpea, with 61 to 62% in desi type and 54 to 71% in kabuli type. It is mainly consumed as 'Dal' (split cotyledons) and chhole. Fresh green leaves are used as vegetables and green grains as hare chhole. Leaves consist of malic and oxalic acids are very useful for stomach ailments and blood purification. Since, chickpea is high in fiber, low in sodium and fat and also cholesterol free, it is beneficial for the prevention of coronary and cardiovascular diseases in human and hence, considered as healthy food (Yadav *et al.*, 2007) [13]. Fertilizers play key role for obtaining higher crop production. Nitrogen plays a vital role in all living plant tissues and constitutes about 1 to 4% on dry weight basis. It imparts green color to leaves, stem and enable them for efficient photosynthesis. It is an integral part of chlorophyll and enzymes essential for plant growth processes. It is also a major component of amino acids and the building blocks of proteins. It is a component of energy transfer compounds, such as ATP and a significant component of nucleic acids such as DNA as well as the genetic material that allows cell to grow and reproduce. Phosphorus is one of the macronutrients for growth and developments of the plants, next to nitrogen. It plays a vital role in the metabolism of plants. The status and fixation capacity of phosphorus in soil strongly influences the availability of phosphorus. However, its concentration and solubilization in soil is low due to its interacting nature and hence phosphorus is a critical nutrient limiting for plant growth. It is called mineral of life. Since there is little scope for horizontal growth in acreage, the only alternative left is to achieve vertical growth through increasing the existing level of production. This emphasizes to think over for the use of thiourea. Foliar applied thiourea improves the CO_2 uptake by stomata. The foliar spray of

thiourea increased the plant photosynthetic efficiency and canopy photosynthesis due to presence of S-H group as an integral constituent of these thiols. Its beneficial effect appears to be due to delayed senescence of both vegetative and reproductive organs as thiourea has cytokinin like activity, particularly delaying senescence (Halmann, 1980) [3]. It helps to overcome such environmental stresses as thiourea offsets the effect of ABA, increases K^+ uptake and decrease the level of cytokinin in plant tissues subjected to water stress due to drought or supra optimal temperatures. Thiourea is a sulphydryl compound. Thiourea contains 42.1% sulphur and 36.8% nitrogen. Initially, thiourea was known for breaking dormancy and germination effects in crops (Mayer, 1956) [5]. Thiourea is sulphydryl compound containing –SH group which has diverse biological activities in plants (Garg and Burman, 2007) [2].

Material and Methods

A field experiment entitled "Influence of Fertilizer Levels and Thiourea Application on Quality, Nutrient Uptake and Economics of Chickpea (*Cicer arietinum* L.)" was conducted at Agronomy Instructional Farm, Chimanbhai Patel College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar, on plot No. A-7 during *rabi* season of 2022-23. The experiment was conducted with three levels of recommended dose of fertilizers and three sprays of thiourea at different stages of plant growth, tried in randomized block design (RBD) with three replications during *rabi* season of 2022. There were twelve treatments *viz*; T_1: 50 % RDF, T_2: 75 % RDF, T_3: 100 % RDF, T_4: 50 % RDF + 500 ppm thiourea at branching, T_5: 50 % RDF + 500 ppm thiourea at pre-flowering, T_6: 50% RDF + 500 ppm thiourea at branching and pre-flowering, T_7: 75 % RDF + 500 ppm thiourea at branching, T_8: 75 % RDF + 500 ppm thiourea at pre-flowering, T_9: 75 % RDF + 500 ppm thiourea at branching and pre-flowering, T_{10}: 100 % RDF + 500 ppm thiourea at branching, T_{11}: 100 % RDF + 500 ppm thiourea at pre-flowering and T_{12}: 100 % RDF + 500 ppm thiourea at branching and pre-flowering (Note: Seed treatment with carbendazim @ 2 g/kg of seeds, Sources of fertilizers were Urea and DAP, RDF = 20:40:00, NPK kg/ha). The soil of the experimental plot was loamy sand in texture, low in organic carbon, available nitrogen and medium in available phosphorus and high in available potassium. Electrical conductivity was very low showing that the soil was free from salinity hazard. Geographically, Sardarkrushinagar is located at 24° 19' North latitude and 72° 19' East longitude with an elevation of 154.52 metre above the mean sea level and situated in the North Gujarat Agro-climatic Zone. The climate of this region is sub-tropical monsoon type and falls under the semi-arid region having extreme cold winter and hot and dry windy summer. During 2022-23, mean maximum temperature ranged between 24.6 to 36.4°C, while mean minimum temperature ranged between 4.9 to 17.3°C during the period of experimentation. The mean relative humidity recorded at morning and evening ranged between 52 to 74 per cent and 33 to 62 per cent, respectively. The wind velocity ranged between 0.3 to 4.6 km/hrs. The bright sunshine hours ranged between 7.0 to 10.0 hrs/day. The overall weather was normal during the investigation period and quite favourable for satisfactory growth and development of chickpea crop. The required quantity of healthy seed was treated with carbendazim @ 2 g/kg seed. The treated seed was kept under shade for two hours and then used for sowing in previously opened furrows in each respective treatment plot. Recommended dose of nitrogen and phosphorus was given through urea and DAP at the time of sowing as per treatments. Foliar spray of thiourea was done with 500 ppm solution at branching and pre-flowering stages as per treatments.

Results and discussion

a. Effect on quality parameters

1. Protein content in seed (%)

Protein content in seed was significantly influenced by treatments. The maximum protein content (19.75%) was recorded under T_{12} (100% RDF + 500 ppm thiourea spray at branching and pre-flowering), which was at par with T_9, T_{10} and T_{11}, while the minimum (16.71%) was observed under T_1 (50% RDF). Higher protein content may be attributed to increased nitrogen uptake and enhanced protein synthesis due to balanced nutrient supply and thiourea application. These findings agree with Rathore *et al.* (2007) [10] and Meena *et al.* (2016) [6].

2. Protein yield (kg/ha)

It is observed from the data summarized in Table 1 that the protein yield influenced significantly by different treatments. The maximum protein yield (412.21 kg/ha) was recorded under T_{12} (100% RDF + 500 ppm thiourea spray at branching and pre-flowering), which was at par with T_9, T_{10} and T_{11}, while the minimum (260.92 kg/ha) was observed under T_1 (50% RDF). Higher protein yield was attributed to increased seed yield and protein content due to balanced nutrient supply and thiourea application. These findings agree with Meena *et al.* (2020) [7] and Singh *et al.* (2018) [11].

Table 1: Protein content in seed (%) and protein yield of chickpea as influenced by different treatments

Treatments	Protein content (%)	Protein yield (kg/ha)
T_1: 50% RDF	16.71	260.92
T_2: 75% RDF	16.75	295.26
T_3: 100% RDF	17.79	318.86
T_4: 50% RDF + 500 ppm thiourea spray at branching	17.10	289.85
T_5: 50% RDF + 500 ppm thiourea spray at pre-flowering	17.10	297.12

T_6: 50% RDF + 500 ppm thiourea spray at branching and pre-flowering	17.67	312.64
T_7: 75% RDF + 500 ppm thiourea spray at branching	17.90	335.78
T_8: 75% RDF + 500 ppm thiourea spray at pre-flowering	17.94	340.45
T_9: 75% RDF + 500 ppm thiourea spray at branching and pre-flowering	18.17	361.16
T_{10}: 100% RDF + 500 ppm thiourea spray at branching	19.02	376.07
T_{11}: 100% RDF + 500 ppm thiourea spray at pre-flowering	19.36	379.68
T_{12}: 100% RDF + 500 ppm thiourea spray at branching and pre-flowering	19.75	412.21
S.Em. ±	0.59	20.83
C.D. at 5%	1.73	61.10
C.V. (%)	5.71	10.88

b. Effect on uptake

1. Nitrogen uptake in seed and stover (kg/ha)

Nitrogen uptake by seed and stover was significantly influenced by different treatments. The maximum uptake (65.94 and 44.40 kg/ha, respectively) was recorded under T_{12} (100% RDF + 500 ppm thiourea spray at branching and pre-flowering), which was statistically at par with T_9, T_{10} and T_{11}. The minimum uptake (41.75 and 29.44 kg/ha) was observed under T_1 (50% RDF). Higher nitrogen uptake may be attributed to increased seed and stover yields, better nutrient availability, enhanced root nodulation and nitrogen fixation, and improved photosynthesis and nitrogen metabolism due to thiourea application. These findings agree with Yakadri *et al.* (2004) [14], Kumar *et al*. (2014) [4], and Premaradhya *et al*. (2018) [9].

2. Phosphorus uptake by seed and stover (kg/ha)

Phosphorus uptake by seed and stover was significantly influenced by treatments. The maximum uptake (9.60 and 7.11 kg/ha) was recorded under T_{12} (100% RDF + 500 ppm thiourea spray at branching and pre-flowering), while the minimum (5.63 and 3.96 kg/ha) was observed under T_1 (50% RDF). Higher uptake was attributed to improved nutrient availability, growth, yield and nutrient absorption, supported by thiourea application. These findings agree with Walley *et al*. (2005) [12] and Patel *et al*. (2013) [8].

c. Economics

The highest gross realization (₹1,08,150/ha) and net realization (₹69,915/ha) were recorded under T_{12} (100% RDF + 500 ppm thiourea spray at branching and pre-flowering), with the highest B:C ratio of 2.83. T_9 ranked second in gross and net realization, while T_{10} recorded the second-highest B:C ratio (2.76). Higher returns were attributed to increased seed and stover yields. These findings agree with Patel *et al*. (2013) [8].

Conclusion

Based on the results of one-year experimentation, it can be concluded that the application of 100% recommended dose of fertilizers (RDF) along with 500 ppm thiourea spray at branching and pre-flowering stages was most effective in improving the quality, nutrient uptake, and net returns of chickpea.

Table 2: Nitrogen and phosphorus uptake and economics of chickpea as influenced by different treatments

Treatments	Nitrogen uptake (kg/ha)		Phosphorus uptake (kg/ha)		Economics	
	Seed	Stover	Seed	Stover	Net returns	BCR
T_1: 50% RDF	41.75	29.44	5.63	3.96	46068	2.32
T_2: 75% RDF	47.24	32.74	6.54	4.16	55731	2.57
T_3: 100% RDF	51.02	34.60	7.11	4.99	56781	2.57
T_4: 50% RDF + 500 ppm thiourea spray at branching	46.38	32.37	6.44	4.27	51999	2.44
T_5: 50% RDF + 500 ppm thiourea spray at pre-flowering	47.54	32.78	6.70	4.15	54048	2.50
T_6: 50% RDF + 500 ppm thiourea spray at branching and pre-flowering	50.01	34.25	6.85	4.72	55773	2.55
T_7: 75% RDF + 500 ppm thiourea spray at branching	53.73	35.16	7.56	5.27	59951	2.64
T_8: 75% RDF + 500 ppm thiourea spray at pre-flowering	54.47	35.47	7.89	5.23	61291	2.68
T_9: 75% RDF + 500 ppm thiourea spray at branching and pre-flowering	57.79	41.97	8.48	6.06	65821	2.75
T_{10}: 100% RDF + 500 ppm thiourea spray at branching	60.16	41.63	8.64	6.32	65555	2.76
T_{11}: 100% RDF + 500 ppm thiourea spray at pre-flowering	58.62	42.48	8.75	6.65	64980	2.75
T_{12}: 100% RDF + 500 ppm thiourea spray at branching and pre-flowering	65.94	44.40	9.60	7.11	69915	2.83
S.Em. ±	3.33	2.38	0.51	0.36	-	-
C.D. at 5%	9.77	6.99	1.50	1.07	-	-
C.V. (%)	10.91	11.32	11.77	12.06	-	-

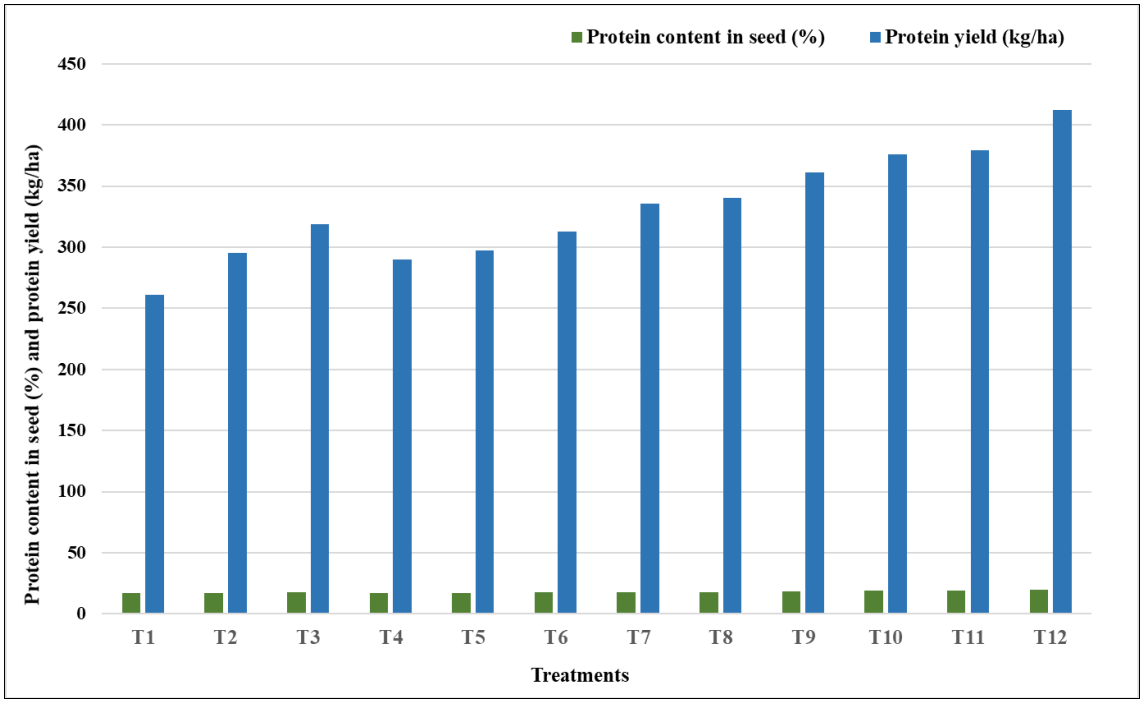


Fig 1: Effect of different treatments on protein content in seed and protein yield of chickpea

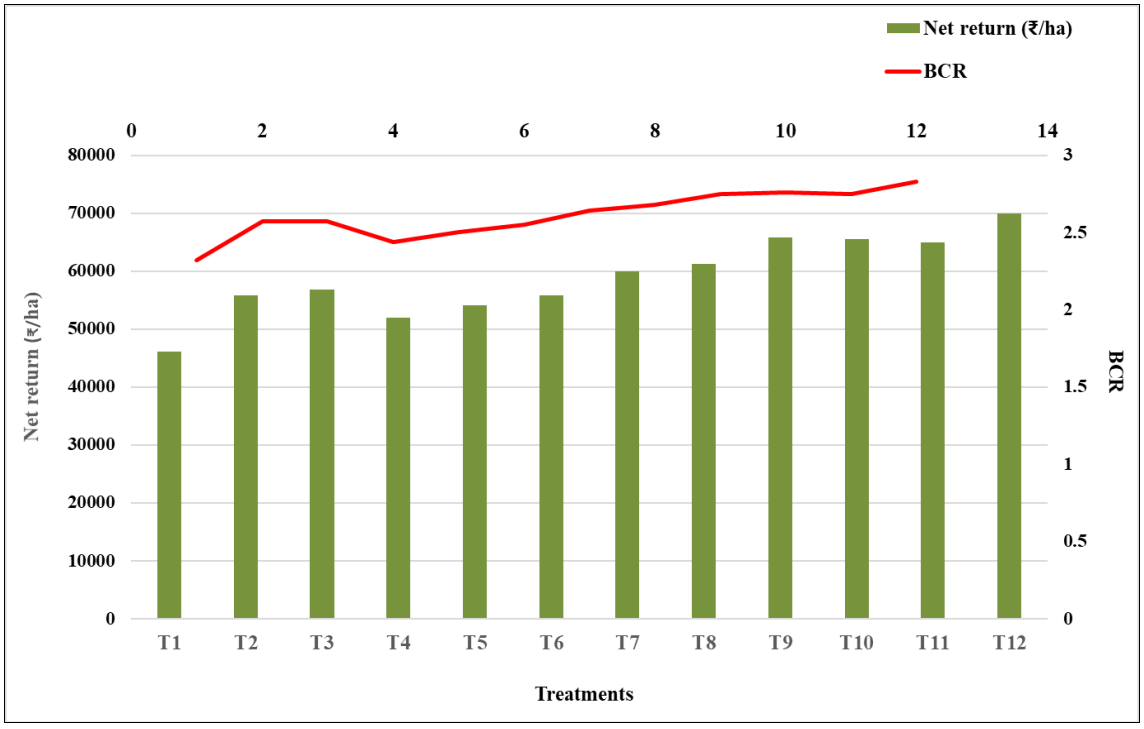


Fig 2: Effect of different treatments on net return and BCR of chickpea (₹/ha)

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