

Original Research Article

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## Effect of Seed Priming and Foliar Spray of Bio-regulators on Yield and Yield Attributes of Chickpea (*Cicer arietinum* L.) under Conserved Moisture Condition

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A three year field experiment was conducted in *rabi* seasons during 2014 to 2016 under conserved moisture condition aims of the experiment to find out the suitable bio-regulator and its effect on chickpea (*Cicer arietinum* L.), experiment treatments were applied as seed soaking with thiourea (500 ppm), salicylic acid (50 ppm), thioglycolic acid (50 ppm (before sowing) and foliar spray of water, thiourea (1000 ppm), salicylic acid (100 ppm) thioglycolic acid (100 ppm) at vegetative stage and flowering stage and one is absolute control in both of factors. Among the treatments imposed, significantly higher seed yield (1759, 1314, 1284 kg ha.) recorded with soaking with thiourea (500 ppm) and foliar spray (1897, 1362, 1337 kg ha.) of thiourea (1000 ppm) over control in all individual three years.

### Introduction

Chickpea (*Cicer arietinum* L.) is approximately 90% of worlds grown in the arid and semi-arid zones under rainfed conditions (Kumar and Abbo, 2001) and fourth most important grain legume with a total global production of 13.1 million ton from 13.5 m ha area & India is the largest producer and consumer of chickpea contributing to 70% of world's total production (Vineeth. et al., 2017). In India drought is the most limiting factor in production in semi-arid ecosystem of

Gujarat. Primarily the failure, prolonged dry spells and erratic behavior of south – west monsoon are the major cause of drought. There is a growing demand for chickpea due to its nutritional value. It is rich source of protein contain about 17-20%. In the semi-arid tropics chickpea is an important component of the diets of those individuals who cannot afford animal proteins or those who are vegetarian by choice. Chickpea is a good source of carbohydrates and protein and cholesterol free. It is also good source of dietary fiber, vitamins and minerals (Maurya et al., 2018) Abiotic stresses such as drought,

salinity, high temperature, low temperature adversely affect plant growth and agricultural productivity. Amongst the various abiotic stresses, drought is the most devastating stress limiting crop production and yield particularly in arid and semi-arid regions (Araujo *et al.*, 2015). It influenced various physiological and biochemical processes, such as translocation, ion uptake, respiration, photosynthesis, carbohydrates, nutrient metabolism and hormones (Farooq *et al.*, 2009), and ended with plant general growth retardations leading to death. In recent years, use of bio-regulators like thiourea, salicylic acid (SA) and thioglycolic acid (TGA) has offered new avenues for enhancing productivity of several crops through stress mitigation. They influence a wide array of physiological parameters like alteration of plant architecture, assimilate partitioning, promotion of photosynthesis, uptake of nutrients (mineral ions), enhancing nitrogen metabolism, increased mobilization of assimilates to defined sinks, induction of synchrony in flowering, and delayed senescence of leaves (Sharma *et al.*, 2013) among the bio-regulator, thiourea proved most efficient because it contains nitrogen and sulfur containing compound with better water solubility and absorption potential is known to impart tolerance against prevailing abiotic stresses. Structurally, its molecule has two main functional groups; 'thiol' is reported vital for oxidative stress response and 'imino' strikingly capable to fulfill the increased N requirement under abiotic stress conditions. Thiols are well-known to maintain the disturbed redox state ( $-SH/-S-S-$  ratio) of the cell and its proper functioning under stress conditions (Nathawat *et al.*, 2007 and Dhikwal *et al.*, 2012).

## Materials and Methods

The experiment was conducted *rabi* session 2014 to 2016 for three years at Agricultural

Research Station, Anand Agricultural University, Dhandhuka, Gujarat. The soil of the experiment field is medium black clay loamy with pH 8.7 and medium range in available nitrogen (215 kg/ha), low in available phosphorus (5.46 kg/ha) and high in available potassium (475 kg/ha) with 0.46 % organic carbon. The total rainfall received during the crop seasons (June to September) was 1050, 715 and 541 mm, respectively. The average rain fall of station is 625 mm. The experiment was laid out in randomization block design (Factorial) with 20 treatment combinations of seed priming ( $S_0$ -No seed soaking,  $S_1$ -seed soaking with thiourea (500 ppm),  $S_2$  - seed soaking with salicylic acid (50 ppm),  $S_3$  - seed soaking with thioglycolic acid (50 ppm) for one hour before sowing and foliar spray ( $C_0$  - No spray (Control),  $C_1$ -water spray,  $C_2$ -thiourea spray (1000 ppm),  $C_3$ -salicylic acid spray (100 ppm),  $C_4$ -thioglycolic acid spray (100 ppm) with three replications. The chickpea variety GG-2 was sown at 30 cm spacing in conserved moisture which is received during month of June and September for respective years and no supplemental irrigation given to crop during the seasons and two foliar sprays of bio-regulators were applied at vegetative and flowering stage of crop. The maximum and minimum temperature fluctuate between 45.5 °C to 8.2 °C. The observation on plant stand/m<sup>2</sup> plant height/cm taken at different stages & for bio-chemical analysis leaf sample was taken after 10 days of each spray whereas, test weight (g) and seed yield (kg ha<sup>-1</sup>) were recorded after harvest. The data from various characters under study were analyzed by the statistics department of Anand Agricultural University- Anand.

## Results and Discussion

The seed priming and foliar spray of bio-regulators significantly influence on the yield & yield attributes (plant height, no of

branches, pods per plant, test weight and seed & biological yield) of rainfed chickpea under conserved moisture condition and data was presented on pooled basis (Table 1 & 2).

### **Yield attributes**

**Seed priming:** Seed priming play an impotent role under conserved moisture condition and significantly influence the yield and yield parameters of chickpea over control. Seed priming with thiourea @ 500 ppm ( $S_1$ ) recorded significantly higher plant population (8.13) per meter over control (7.27) and found at par with TGA @ 50 ppm ( $S^3$ ) (7.99). In addition to breaking innate dormancy (El-Keblawy and Gairola, 2017), the seed treatment with thiourea accelerates the seed germination in non-dormant seeds. The data showed in Table 1 for plant height indicate that significantly higher data was recorded with thiourea @ 500 ppm ( $S_1$ ) in the tune of 48.47 cm over control (45.58) while found at par with TGA @ 50 ppm( $S_3$ ). The thiourea with its sulphydryl group regulates several metabolic reactions in the plant both under normal as well as stress conditions. Under stress conditions it acts as an antioxidant by protecting primary photochemical reactions of photosystem 1 and photosystem 2 and enhances the activities of antioxidant enzymes (Nathawat *et al.*, 2007). Seed priming with thiourea @ 500 ppm ( $S_1$ ) gave superior results in case of number of branches per plant, number of pods per plant, number of seed per pod and test weight (g) which is 7.68, 76.05, 1.11 and 34.11 respectively, over (7.10, 70.31, 1.03 & 32.50) control. Number of branches (7.64) and seed per pod (1.08) found at par with TGA seed priming @ 50 ppm ( $S_3$ ) while number of pods per plant (74.87) and test weight (33.41) at par with SA seed priming @ 50 ppm ( $S_2$ ). The thiourea application might have favoured the greater translocation of assimilates from source to sink for longer period in comparison to

control treatment which lead to effective grain filling. Sahu *et al.*, (1993) and Shanu *et al.*, (2013) also reported improvement yield attributes of coriander with seed priming and foliar spray of thiourea. Presoaking sowing process elevates the negative effect of drought and makes active in metabolic process (Murad *et al.*, 2016)

**Chemical spray:** A great number of studies provide evidence regarding role of foliar spray applied thiourea in modulating physiological mechanisms and improve final yield. Foliar spray of thiourea @1000 ppm ( $C_2$ ) significantly improve yield and yield attributes (Table 1). Due to foliar spray of thiourea @1000 ppm ( $C_2$ ) plant stand per meter row (8.41), plant height/cm (48.68), number of branches per plant (7.94), number of pods per plant (77.96), number of seed per pod (1.16) and test weight/g (34.25) influence significantly over control, 7.53, 45.56, 6.99, 70.87, 1.04 & 32.45 respectively, on pooled basis of three years and found at par with  $C_3$  treatment (SA spray (100 ppm) in case of plant stand per meter row (7.83), number of branches per plant (7.47), number of pods per plant (73.80), number of seed per pod (1.07) and test weight/g (33.50) whereas plant height/cm (47.96) found at par with  $C_4$  treatment (TGA spray (100 ppm)).

Foliar spray of 5mM thiourea improved the photo-system activity along with the expression of antioxidant (both enzymatic and non-enzymatic system) (Hassanein *et al.*, 2015). Previous studies confirm that thiourea increased the plant growth under salt stress condition, which might be due to increase in antioxidant activities that alleviated the stress damage (Francisco *et al.*, 2008 & Perveen *et al.*, 2015).

**Interaction effect:** Seed priming and foliar spray of stress mitigating bio-regulators interaction effect was found non significant in

all yield parameters in individual years and in pooled analysis (Table 1).

### **Yield & B: C ratio**

**Seed priming:** Perusal of data presented in Table 2 revealed that effect of different seed priming treatment on seed protein was found significant and higher data were recorded with S<sub>1</sub> treatment (Thiourea @ 500 ppm) (17.83 %) over control S<sub>0</sub> (17.33%) in pooled analysis of three years while data found at par with S<sub>3</sub> treatment (17.79%). Due to application of SH- compounds had significant influence on protein yield of grains confirmed by Meena and Sharma (2005). Thiourea also plays favourable role to increase soluble protein and free amino acids (Garg *et al.*, 2006) and thiols been found to enhance the translocation of sucrose from source to sink. Among the various seed priming treatment significantly higher seed yield kg/ha was recorded with S<sub>1</sub> treatment (Thiourea @ 500 ppm) and magnitude data is 1452 kg/ha in

comparison to the lowest (1305 kg/ha) recorded with control which remained at par with S<sub>2</sub> treatment (SA @ 50 ppm) (1386 kg/ha). Treatment S<sub>3</sub> (TGA @ 50 ppm) rank third in performance (1371 kg/ha) but it remained at par with S<sub>2</sub> treatment (SA @ 50 ppm) (1386 kg/ha) and significantly higher over control on basis of three year pooled analysis. Same trend was found in biological yield of chickpea and appreciably data associated with S<sub>1</sub> treatment (Thiourea @ 500 ppm) which is 2192 kg/ha over control (1987 kg/ha) and remained at par with S<sub>3</sub> treatment (TGA @ 50 ppm) (2165 kg/ha) on basis of three year pooled analysis. Thiourea with its sulphydral group not only favoured larger green photosynthetic surface but it might have also favoured the activity of starch synthetase and hence the effective period of filling seeds (Shanu *et al.*, 2013) and ultimately yield is increase. Higher B:C ratio (2.59) was recorded with S<sub>1</sub> treatment (Thiourea @ 500 ppm) in comparison to control (2.27).

**Table.1** Effect of seed priming and foliar spray of stress mitigating chemical on yield attributes of rainfed chickpea under conserved moisture condition

Treatment	Yield attributes of chickpea					
	Plant Stand/m	plant height/cm	No of branches /plant	No of pods/plant	No of seeds/plant	Test weight/g
<b>(A) Seed Priming</b>						
S <sub>0</sub> : Control	7.27	45.58	7.10	70.31	1.03	32.50
S <sub>1</sub> : Thiourea priming (500 ppm)	8.13	48.47	7.68	76.05	1.11	34.14
S <sub>2</sub> : SA priming (50ppm)	7.81	47.23	7.32	74.87	1.07	33.41
S <sub>3</sub> : TGA priming (50ppm)	7.99	47.52	7.64	74.85	1.08	33.40
SEM <sub>±</sub>	0.12	0.37	0.12	0.62	0.01	0.27
CD@5%	0.34	1.05	0.33	1.77	0.04	0.77
<b>(B) Chemical Spray</b>						
C <sub>0</sub> : Control	7.53	45.56	6.99	70.87	1.04	32.45
C <sub>1</sub> : Water spray	7.48	47.04	7.42	73.86	1.04	33.14
C <sub>2</sub> : Thiourea spray (1000 ppm)	8.41	48.68	7.94	77.96	1.16	34.25
C <sub>3</sub> : SA spray (100ppm)	7.83	46.75	7.47	73.80	1.07	33.50
C <sub>4</sub> : TGA spray (100ppm)	7.77	47.96	7.37	73.62	1.05	33.48
SEM <sub>±</sub>	0.13	0.41	0.13	0.69	0.02	0.30
CD @ 5%	0.39	1.19	0.38	2.00	0.05	0.87
S x C	NS	NS	NS	NS	NS	NS
CV%	5.93	3.02	6.06	3.24	5.14	3.11

**Table.2** Effect of seed priming and foliar spray of stress mitigating chemical on protein, yield, and economics of rainfed chickpea under conserved moisture condition

Treatment	Seeds protein (%)	Seed yield (kg/ha)	Biological yield (kg/ha)	B:C ratio
<b>(A) Seed Priming</b>				
S <sub>0</sub> : Control	17.33	1305	1987	2.27
S <sub>1</sub> : Thiourea priming (500 ppm)	17.83	1452	2192	2.59
S <sub>2</sub> : SA priming (50ppm)	17.72	1386	2152	2.45
S <sub>3</sub> : TGA priming (50ppm)	17.79	1371	2165	2.42
Sem±	0.12	20.23	30.55	-
CD@5%	0.35	57.91	87.45	-
<b>(B) Chemical Spray</b>				
C <sub>0</sub> : Control	17.64	1275	2001	2.21
C <sub>1</sub> : Water spray	17.45	1317	2082	2.23
C <sub>2</sub> : Thiourea spray (1000 ppm)	17.92	1532	2226	2.67
C <sub>3</sub> : SA spray (100ppm)	17.50	1392	2138	2.36
C <sub>4</sub> : TGA spray (100ppm)	17.83	1375	2173	2.35
Sem±	0.14	22.62	34.15	-
CD @ 5%	NS	65.31	98.62	-
S x C	Sig	NS	Sig	-
CV%	2.65	5.68	5.57	-

**Table.3** Interaction of seed priming and foliar spray of stress mitigating chemicals on seed protein (%) of rainfed chickpea in pooled analysis

Chemical spray	Seed priming				
	S <sub>0</sub>	S <sub>1</sub>	S <sub>2</sub>	S <sub>3</sub>	Mean
C <sub>0</sub>	16.66	17.89	18.19	17.83	17.64
C <sub>1</sub>	17.20	17.35	17.62	17.63	17.45
C <sub>2</sub>	18.10	<b>18.72</b>	17.18	17.69	17.92
C <sub>3</sub>	17.25	17.80	16.99	17.96	17.50
C <sub>4</sub>	17.47	17.40	18.60	17.86	17.83
Mean	17.33	17.83	17.72	17.79	
Sem±	0.27				
CD @ 5%	0.78				
CV%	2.65				

**Table.4** Interactive effect of seed priming and foliar spray of stress mitigating chemicals on biological yield (kg/ha) of rainfed chickpea in pooled analysis

Chemical spray	Seed priming				
	S <sub>0</sub>	S <sub>1</sub>	S <sub>2</sub>	S <sub>3</sub>	Mean
C <sub>0</sub>	1701	2056	2161	2088	2002
C <sub>1</sub>	1892	2165	2133	2139	2082
C <sub>2</sub>	2058	<b>2333</b>	2138	2375	2226
C <sub>3</sub>	2120	2117	2169	2148	2139
C <sub>4</sub>	2166	2289	2161	2078	2174
Mean	1987	2192	2153	2166	
Sem±	68				
CD @ 5%	197				
CV%	5.57				

**Chemical spray:** A perusal of data presented in Table 2 regarding spray of stress mitigating bio-regulators reveled that significantly higher data recorded in regarding seed protein with C<sub>2</sub> treatment (Thiourea @ 1000 ppm) (17.92 %) over control C<sub>0</sub> (17.64%) on basis of three year pooled analysis and remain at par with C<sub>4</sub> treatment (TGA @ 100 ppm). A significant higher data seed and biological yield was recorded with C<sub>2</sub> treatment (Thiourea @ 1000 ppm) is 1532 & 2226 kg/ha over control (C<sub>0</sub>) is 1257 & 2001 kg/ha respectively, whereas second and third position occupied by C<sub>3</sub> (1392 kg/ha) & C<sub>4</sub> (1375 kg/ha) treatment in case of seed yield while in biological yield second and third position occupied by C<sub>4</sub> (2173 kg/ha) & C<sub>3</sub> (2138 kg/ha) treatment, respectively. These result closely confirmed by Abhishek *et al.* (2019) according to foliar spray of thiourea @ 1000 ppm apply to chickpea crop gave significantly higher yield as compare to control. Ample support to such effects in maize due to foliar spray of thiourea @ 1000 ppm was also reported by Sahu *et al.*, (1993). In response of B:C ratio the higher data originate with C<sub>2</sub> treatment(2.67) (Thiourea @ 1000 ppm) in comparison to control (2.21).

**Interaction Effect:** Seed priming (S) and foliar spray (C) of stress mitigating bio-regulators interaction effect was found significant (Table 3 and 4) in case of seed protein and biological yield on the pooled analysis basis and combination found is S<sub>1</sub>C<sub>2</sub> whereas, in case of seed yield it is found non significant (Table 2).

Based on present study, it was concluded that that thiourea application has significant influence on chickpea productivity. Seed priming of chickpea seeds in @ 500 ppm thiourea and its sprays (1000 ppm) one at vegetative and one at flowering stage resulted in good productivity of chickpea and was most remunerative as compared with the other

treatments and control. This could have the utility against different stresses and offered as a solution to the problem faced with drought stress.

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