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Effect of hydrogel and foliar nutrition sprays on seed yield and economics of chickpea under rainfed situation in Chhattisgarh plains

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Abstract
The present investigation "Effect of Hydrogel and Foliar nutrition sprays on seed yield and economics of chickpea under rainfed situation in Chhattisgarh plains" was conducted at Instructional Cum Research Farm of IGKV, Raipur (Chhattisgarh) during Rabi season in 2018-19 and 2019-20. The soil was clayey (*Vertisols*) in texture, locally known as "*Kanhar*". The experiment comprised of 2 hydrogel levels (i.e. 0 & 5.0 kg/ha) were kept in main plots and 5 levels of foliar nutrition (i.e. water spray (control), urea 2%, thiourea 500 ppm, salicylic acid 100 ppm & NPK (19:19:19) @ 0.5%) in sub plots. Hydrogel was putted 4-5 cm deep into the soil before chickpea sowing and subsequently foliar nutrition were sprayed flower initiation and pod development stages. Result revealed that application of hydrogel 5.0 kg/ha before sowing recorded significantly higher seed yield (1680.05 and 1716.91 kg/ha), stover yield (2610.22 and 2664.81 kg/ha) and net return (Rs. 52893.26 and 54606.73/ha) during both the years and on mean basis respectively. While, maximum B: C ratio (2.17 and 3.25) during both the years and on mean basis was fetched with 0 kg/ha hydrogel. Foliar application of urea 2% at flower initiation & pod development stages recorded significantly higher seed yield (1714.10 and 1756.36 kg/ha), stover yield (2642.35 and 2691.86 kg/ha), net return (Rs. 56709.70 and 58661.14/ha) and B:C ratio (2.45 and 3.55) during both the years and on mean basis which was at with thiourea 500 ppm over water spray and salicylic acid 100 ppm, respectively.

Keywords: Chickpea, foliar nutrition, hydrogel, seed and stover yield, economics, salicylic acid, thiourea, urea

Introduction

The name chickpea comes from the Latin word *cicer*, referring to the plant family of legumes, Fabaceae. Chickpea (*Cicer arietinum* L.) is an important pulse crop of rabi season cultivated mainly in semi-arid and warm temperate regions of the world. These plants produce edible seeds, called pulses, that have high nutritional value. Two main varieties of chickpeas are the larger round light-colored Kabuli-type, common in the United States, and the smaller dark irregularly shaped Desi-type often used in India and the Middle East. India produces the most chickpeas worldwide but they are grown in more than 50 countries. It contains 18 to 24% protein which is almost three times more than that of cereals and had an excellent source of carbohydrate, fiber, B vitamins, and some minerals, they are a nutritious staple of many diets. Chickpea is grown in more than 50 countries Chickpea is grown in more than 50 countries (89.7% area in Asia, 4.3% in Africa, 2.6% in Oceania, 2.9% in Americas and 0.4% in Europe). India is the largest chickpea producing country accounting for 64% of the global chickpea production.

Rainfed agriculture has a protruding role to play in India's agriculture and economy. India ranks first among the rainfed countries in the world in terms of area, however, it counts the lowest in yields (around 1 ton/ha) [Kalhapure *et al*., 2016] [4]. Rainfed areas are home to the majority of rural poor and marginal farmers, who come across multiple risks and uncertainties relating to bio-physical and socio-economic conditions resulting in poverty, malnutrition, water scarcity, severe land degradation, lower yields, low investments, and poor physical and social infrastructure. Rainfed agriculture supports four out of every ten Indians, and comprises 60% to 70% of total cropped area (85 million hectare), 48% of the area under food crops, and 68% of the area under non-food crops [Vundavalli *et al*., 2015] [9]. More than 75% of pulses, 66% of oilseeds, and 45% of cereals are grown under rainfed conditions [Kalhapure *et al*., 2016] [4]. Though the maximum area is under rainfed, negligence is shown towards its upliftment.

Despite this systematic neglect, yields of coarse grains, oilseeds, and pulses are increasing faster under rainfed than in irrigated.

Pradeep Kumar *et al*., 2016 investigated that the super absorbent polymer hydrogel potentially influence soil permeability, density, structure, texture, evaporation and infiltration rates of water through the soils. Particularly, the hydrogels reduce irrigation frequency and compaction tendency, stop erosion, water runoff and increase the soil aeration and microbial activity. The hydrogel gradually releases up to 95% of its stored water when its surroundings begin to dry out. But, when comes in contact with water again, it gets replenished. This process can last up to 2-5 years, by which time biodegradable hydrogel decomposes to CO2, water and ammonia and potassium ions, without any residue, thus, environment friendly (Trenkel, 1997) [8]. Nutrient management (Major & Minor) is the main component for sustainable chickpea production along with foliar application of water soluble fertilizers at appropriate stages of growth may also ameliorate the nutrient deficiency as well as mitigate the heat stress. It is therefore to measure the adoption of improved appropriate water conserving technologies for enhancing the yield and economics of chickpea. Keeping this in view, a field experiment was carried out to find out the effective dose of hydrogel with suitable foliar nutrition at critical stages for enhancing yield and economics of chickpea under vertisols.

Material and Methods

The experiment was conducted at Instructional Cum Research Farm of Indira Gandhi Krishi Vishwavidyalaya, Raipur (Chhattisgarh) during Rabi season in 2018-19 and 2019-20. The soil was clayey (*Vertisols*) in texture, locally known as "*Kanhar*" which was low, medium and high in available N, P_2O_5 and K_2O, respectively. The experiment comprised of 2 hydrogel levels (i.e. 0 & 5.0 kg/ha) were kept in main plots and 5 levels of foliar nutrition (i.e. water spray (control), urea 2%, thiourea 500 ppm, salicylic acid 100 ppm & NPK (19:19:19) @ 0.5%) in sub plots. The experiment was laid out in split plot design and replicated three times. The soil was Coarse sand 5.32%, Fine sand 14.91%, Silt 35.35%, clay 44.42% in texture with pH 7.2, organic carbon (0.69%), low in available N (232 kg/ha), medium in available P (12.24 kg/ha) and high in exchangeable K (382.6 kg/ha). Hydrogel was putted into the soil before chickpea sowing in earmarked strips and subsequently foliar nutrition were sprayed at critical stages i.e. flower initiation and pod development. The recommended dose of fertilizer (20 kg N, 50 kg P, 20 kg K/ha) was putted into the soil at the time of sowing and seeds were treated with fungicides, Trichoderma and rhizobium @ 10 g/kg of seeds. The chickpea variety "Indira Chana1" was used for experimental purpose and sown on 26th November, 2018 and 28th November, 2019 sown at RxR 30 cm spacing, respectively by adopting the recommended seed rate of 80 kg/ha. Weeds were managed by hand weeding at 25-30 days after sowing. The plant protection measures were taken up as and when required. At maturity, seed yield were recorded. Harvest index was calculated by dividing economical yield by total biomass production. Gross return, Net returns as well as B: C ratios were also worked out. All data were subjected to analysis of variance.

Results and Discussion

Yield

Application of hydrogel 5.0 kg/ha was recorded maximum and significantly higher seed yield (1680.05 and 1716.91 kg/ha), straw yield (2610.22 and 2664.81 kg/ha) and harvest index (39.15 and 39.17%) during both the years and on mean basis, respectively over no hydrogel (Table 1). Foliar application of nutrients at flower initiation and pod development stages had positive effect on seed yield. The data based on two years and on mean basis further revealed that foliar application of urea 2% at flower initiation & pod development stages recorded maximum and significantly higher seed yield (1714.10 and 1756.36 kg/ha), straw yield (2642.35 and 2691.86 kg/ha) and harvest index (39.34 and 39.47%) and it was at par with thiourea 500 ppm over water spray, salicylic acid 75 ppm and NPK 19:19:19 @ 0.5%, respectively. But the higher harvest index (39.34 and 39.47%) was recorded with the foliar application of urea 2% at flower initiation & pod development stages and was on par with NPK 19:19:19 @ 0.5% over water spray, thiourea 500 ppm and salicylic acid 75 ppm. It may be due to application of super absorbent polymers (hydrogel) improves plant growth by increasing water holding capacity in soils (Boatright *et al*., 1997) [1] and delaying the duration to wilting point in drought stress (Gehring and Lewis, 1980) [3].

Economics

The higher cost of cultivation (Rs. 25319/ha), gross return (Rs. 78212.26 and 79925.73/ha) and net return (Rs. 52893.26 and 54606.73/ha) was recorded with the application of 5 kg hydrogel per hectare during both the years and on mean basis, respectively over without hydrogel (Table2). Whereas, maximum and significantly higher B:C ratio (2.17 and 3.25) was fetched during both the years and on mean basis with 0 kg/ha hydrogel. Foliar application of nutrients at flower initiation and pod development stages had positive effect on economics of chickpea. The data based on two years and on mean basis further revealed that foliar application of urea 2% at flower initiation & pod development stages recorded maximum and significantly gross return (Rs. 79776.70 and 81728.14/ha), net return (Rs. 56709.70 and 58661.14/ha) and B:C ratio (2.46 and 3.55) also being on par with thiourea 500 ppm over water spray, salicylic acid 75 ppm and NPK 19:19:19 @ 0.5%, respectively. But the higher cost of cultivation (Rs. 23807) was recorded with the foliar application of thiourea 500 ppm at flower initiation & pod development stages and it was on par with NPK 19:19:19 @ 0.5% over water spray, thiourea 500 ppm and salicylic acid 75 ppm. This might be probably spray of NPK 19:19:19 @ 0.5% and urea 2% spray improved nitrogen supply to leaf by foliar absorption might have delayed the senescence of leaves and allowed greater soil total assimilation and carbon remobilization to the seeds of additional pods reported by Palta *et al*., 2005 [6].

Table 1: Effect of hydrogel and foliar nutrition on seed yield, stover yield and harvest index of chickpea

Treatment	Seed yield (kg/ha)			Stover yield (kg/ha)			Harvest index (%)		
	2018-19	2019-20	Mean	2018-19	2019-20	Mean	2018-19	2019-20	Mean
Main plot (Hydrogel application (kg/ha))									
O kg/ ha (T1)	1458.66	1492.12	1475.39	2301.14	2360.85	2330.99	38.79	38.71	38.75

5 kg/ha (T2)	1680.05	1716.91	1698.48	2610.22	2664.81	2637.52	39.15	39.17	39.16
CD (0.05%)	128.72	146.08	137.36	219.82	195.86	207.12	NS	NS	NS
Sub plot (Foliar nutrition application)									
Water spray (control) (F1)	1428.97	1464.00	1446.49	2329.97	2384.18	2357.08	38.00	38.03	38.02
Urea 2% (F2)	1714.10	1756.36	1735.23	2642.35	2691.86	2667.11	39.34	39.47	39.41
Thiourea 500 ppm (F3)	1614.82	1643.92	1629.37	2503.31	2558.65	2530.98	39.22	39.12	39.17
Salicilic acid 100 ppm (F4)	1516.20	1550.21	1533.21	2373.53	2434.25	2403.89	38.98	38.91	38.94
NPK (19:19:19) 0.5% (F5)	1572.68	1608.09	1590.38	2429.23	2495.20	2462.22	39.29	39.18	39.23
CD at 5%	111.96	118.12	114.80	191.14	192.00	191.21	0.81	0.68	0.73

Table 2: Effect of hydrogel and foliar nutrition on economics of chickpea

Treatments	Gross return (Rs.)			Cost of cultivation (Rs.)	Net return (Rs.)			B:C Ratio		
	2018-19	2019-20	Mean	Mean	2018-19	2019-20	Mean	2018-19	2019-20	Mean
Main plot (Hydrogel application (kg/ha))										
O kg/ ha (T1)	67940.87	69506.34	68723.60	21419	46521.87	48087.34	47304.60	2.17	3.25	3.21
5 kg/ha (T2)	78212.26	79925.73	79069.00	25319	52893.26	54606.73	53750.00	2.09	3.16	3.12
CD (0.05%)	5994.07	6732.25	6361.39		5994.07	NS	6361.39	NS	NS	NS
Sub plot (Foliar nutrition application)										
Water spray (control) (F1)	66633.62	68264.33	67448.98	22907	43726.62	45357.33	44541.98	1.91	2.98	2.94
Urea 2% (F2)	79776.70	81728.14	80752.42	23067	56709.70	58661.14	57685.42	2.46	3.55	3.50
Thiourea 500 ppm (F3)	75170.36	76534.98	75852.67	23807	51363.36	52727.98	52045.67	2.16	3.22	3.19
Salicilic acid 100 ppm (F4)	70602.53	72193.70	71398.12	23507	47095.53	48686.70	47891.12	2.01	3.08	3.04
NPK(19:19:19) 0.5% (F5)	73199.61	74859.03	74029.32	23557	49642.61	51302.03	50472.32	2.11	3.18	3.15
CD at 5%	5212.61	5494.43	5343.31		5212.61	5494.43	5343.31	0.23	0.24	0.23

Conclusions

The relevant study based on both the years and on mean basis it concluded that application of hydrogel 5.0 kg/ha before chickpea sowing and subsequently foliar spray of either urea 2% or thiourea 500 ppm at flower initiation and pod development was found effective for increasing seed yield and economics of chickpea. Hence, hydrogel along with foliar application of either urea 2% or thiourea 500 ppm may become a practically convenient and economically feasible and viable option in water-scarce areas for enhancing the agricultural productivity by achieving sustainability in production.

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