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Effect of hydrogel applications and foliar nutrition sprays on yield attributes, seed and stover yield of chickpea crop

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Abstract
A field experiment was conducted at Instructional Cum Research Farm of IGKV, Raipur (Chhattisgarh) during Rabi season in 2018-19 and 2019-20 to study the "Effect of hydrogel and foliar nutrition sprays on yield attributes, seed and stover yield of chickpea". 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 was laid out in split plot design with 3 replications and comprised of 2 hydrogel levels i.e. 0 kg/ha & 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 at critical stages i.e. flower initiation and pod development. Result revealed that application of hydrogel 5.0 kg/ha before sowing recorded significantly higher pods/plant (38.42 and 39.24), seeds/pod (1.57 and 1.61), 100 seed weight (25.36 and 25.53 g), seed yield (1680.05 and 1716.91 kg/ha) during both the years and on mean basis respectively. Foliar application of urea 2% at flower initiation & pod development stages recorded significantly higher pods/plant (39.94 and 40.73), seeds/pod (1.67 and 1.63), 100 seed weight (26.00 and 26.18 g), seed yield (1714.10 and 1756.36 kg/ha) during both the years and on mean basis which was at par with thiourea 500 ppm over water spray and salicylic acid 100 ppm, respectively.

Keywords: chickpea, foliar nutrition, hydrogel, yield attributes, seed and stover yield, salicylic acid, thiourea, urea

1. Introduction
Chickpea is a cool season legume crop grown world-wide as a food crop. The seed is the main edible part of the plant. It is also called garbanzo gram or Bengal gram. It ranks third (FAO, 2008) among the food legumes after beans and pea. More than 50 countries are reported to grow chickpea; 22 cultivate more than 20,000 ha, and 19 cultivate 10,000 to 20,000 ha. Major chickpea-producing countries are: India (65% of annual production), Pakistan (10%), Turkey (7%), Iran (3%), Myanmar (2%), Mexico (1.5%) and Australia (1.5%) (FAO, 2008). India is the largest producer of chickpea and it accounts for about 33.99 % of the total area and 40.92% of total pulse production in the country. However, it is cultivated over an area of 10.56 m.ha, producing 11.23 m.tonne and productivity of 1063 kg/ha in India (Anonymous, 2018) [1].
Hydrogel is a synthetic polymers in the form of crystals or tiny beads available under several trade names such as super absorbent polymers, root watering crystals and drought crystals. They have enormous capacity to absorb water when it comes by and make it available to plants over time. The addition of hydrogel at the rate of 2 g/kg increased the water holding capacity of coarse sand from 171 to 402% (Johnson 1984a). Further, hydrogel addition improved water storage properties of porous soils and resulted in the delay and onset of permanent wilting percentages under intense evaporation. An increase in water holding capacity due to hydrogel significantly reduced the irrigation requirement of many plants (Taylor and Halfacre 1986).
The chickpea is constrained mainly by terminal drought because it is traditionally cultivated as a winter crop using either conserved soil moisture or limited irrigation facility. However, soil fertility especially macro and micronutrients, imbalanced use of fertilizer and occurrence of physiological disorders factors such as poor pod setting, excessive flower detachment and lack of nutrient during critical stages of crop growth leads to nutrients stress, poor growth and yield. Thus additional nutrition through foliar feeding is played a vital role to fulfill the nutritional requirement in critical stages of chickpea. Foliar nutrition is a technique of feeding plant by liquid fertilizer directly to their leaves (Tiwari *et al.*) [10]. Foliar nutrition provides rapid nutrient supply, especially when soil nutrient availability or root activity is reduced.

Hence, the present study was carried out to evaluate the effect of hydrogel applications foliar nutrients sprays on yield attributes, seed and stover yield chickpea crop.

2. Material and Methods

A field experiment was carried out at Instructional Cum Research Farm of Indira Gandhi Krishi Vishwavidyalaya, Raipur (Chhattisgarh) in 2018-19 and 2019-20 during Rabi season. The soil type of experimental site was clayey (*Vertisols*) in texture with pH 7.2, locally known as "*Kanhar*" which was low, medium and high in available N, P_2O_5 and K_2O, respectively. The experiment was laid out in split plot design and replicated three times and 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. There was a total rainfall of 92.6mm and 149.6mm during the cropping period from 12th November to 25th march 2018-19 and 12th November to 25th March 2019-20. 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. The chickpea variety "Indira Chana1" was used for experimental purpose and was 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. The crop was harvested during 29 March 2019 and 20 March 2020. Weeds were managed by hand weeding at 25-30 days after sowing. The plant protection measures were taken up as and when required. In each plot five plants were randomly selected and tagged to record biometric observations on growth and yield attributes. At maturity, pods/plant, seeds/pod, 100-seed weight, biological yield and seed yield were recorded. All data were subjected to analysis of variance.

3. Results and Discussion

3.1 Yield attributes

The results showed that application of hydrogel had positive effect on yield attributes as compared to without application of hydrogel in the soil (Table 1). Application of hydrogel 5.0 kg/ha before sowing recorded maximum number of pods/plant (38.42 and 39.24), number of seeds/pod (1.57 and 1.61) and 100 seed weight (25.36 and 25.53 g) significantly during both the years and on mean basis, respectively. This might be due to water conservation by hydrogel creates a buffered environment being effectiveness in short term drought tension and losses reduction in early establishment phase in the chickpea plant. Hence, super absorbent polymers (hydrogel) causes improvement in plant growth by increasing water holding capacity in soils (Boatright *et al*., 1997) and delaying the duration to wilting point in drought stress (Gehring and Lewis, 1980) [3]. Therefore, totally proficiency in water consumption and dry matter production are positive plant reactions by the super absorbent application (Woodhouse and Johnson, 1991). Foliar application of nutrients at flower initiation and pod development stages had positive effect on increasing yield attributes of chickpea. The data based on two years and on mean basis were found that foliar application of urea 2% at flower initiation & pod development stages recorded significantly higher number of pods/plant (39.94 and 40.73), number of seeds/pod (1.67 and 1.63) and 100 seed weight (26.00 and 26.09 g) being on par with thiourea 500 ppm over water spray, salicylic acid 75 ppm and NPK 19:19:19 @ 0.5%, respectively. The foliar spray of NPK 19:19:19 @ 0.5%, salicylic acid 75 ppm and thiourea 500 ppm increased dark fixation of CO2 in embryonic tissues of plant has diverse biological activities. Its beneficial effect might be appears due to delayed senescence of both vegetative and reproductive organs as thiourea has cytokinin like activity particularly on delaying senescence (Halmann, 1980) [4]. These regulators are also known to increase photosynthetically active leaf surface during grain filling period (Sahu *et.al*. 1993) [8].

3.2 Yield

Hydrogel application of 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 0 kg/ha 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 rest of the treatments. 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.

Table 1: Effect of hydrogel and foliar nutrition on yield attributing characters of chickpea

Treatments	Pods / Plant (No.)			Seeds /Pods (No.)			100 Seed weight (g)		
	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)	35.88	36.52	36.20	1.36	1.33	1.35	24.09	24.23	24.16
5 kg/ha (T2)	38.42	39.24	38.83	1.57	1.61	1.59	25.36	25.53	25.45
CD (0.05%)	0.66	1.50	0.93	NS	NS	NS	0.72	0.68	0.70
Sub plot (Foliar nutrition application)									
Water spray (control) (F1)	33.37	33.87	33.62	1.27	1.30	1.28	23.87	24.00	23.94
Urea 2% (F2)	39.94	40.73	40.33	1.67	1.63	1.65	26.00	26.18	26.09
Thiourea 500 ppm (F3)	38.60	39.33	38.97	1.53	1.53	1.53	25.53	25.67	25.60
Salicilic acid 100 ppm (F4)	35.70	36.93	36.32	1.43	1.43	1.43	22.84	22.99	22.92
NPK (19:19:19) 0.5% (F5)	38.14	38.53	38.34	1.43	1.47	1.45	25.40	25.57	25.49
CD at 5%	1.45	1.80	1.56	0.17	0.20	0.14	0.83	0.84	0.83

Table 2: Effect of hydrogel and foliar nutrition on seed yield, stover yield and harvest index of chickpea

Treatments	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

4. Conclusions

From the present investigation it was concluded that the application of hydrogel 5.0 kg/ha before chickpea sowing was found higher yield attributes and seed yield of chickpea. And the foliar nutrition treatment with the spray of urea 2% or thiourea 500 ppm at flower initiation and pod development was found the best practices for getting higher production in chickpea under rainfed condition. Hence, hydrogel along with foliar application of either urea 2% or thiourea 500 ppm may become practically convenient and economically possible and successful option in water-stressed areas for increasing agricultural productivity.

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