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Effect of hydrogel application and foliar spray of nutrients on yield and yield attributes of chickpea (*Cicer arietinum* L.) under limited irrigation supply

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Abstract

In order to find out the effect of hydrogel application and foliar nutrients spray on chickpea an experiment entitled "Effect of hydrogel application and foliar spray of nutrients on yield and yield attributes of chickpea (*Cicer arietinum* L.) under limited irrigation supply" was conducted during *rabi* season of 2020-21. The experiment was conducted at Research cum Instructional farm IGKV Raipur. The treatments comprised of two levels of hydrogel application (0 kg ha^{-1} hydrogel; 5 kg ha^{-1} hydrogel) and six levels of foliar nutrients spray (F_1- water spray, F_2- urea 2%, F_3- thiourea 500 ppm, F_4- salicylic acid 100 ppm, F_5- NPK(19:19:19:), F_6- DAP 2%). The experiment was laid out in split plot design with three replications having hydrogel application as main plot and foliar nutrients spray as sub plot treatment. The region has sub humid to semi-arid climate. The chickpea variety Indira chana-1 was taken as test crop and sown on November 30th, 2020 and harvested on March 25th, 2021. The seed rate of 80 kg ha^{-1} treated with rhizobium culture was used for the sowing. A basal application of 20:50:20 kg ha^{-1} N: P_2O_5: K_2O was given to the crop as a basal application. One irrigation was applied just after sowing of the crop. The 5 kg ha^{-1} hydrogel as per treatment was drill in line before seeding of chickpea seeds. The foliar nutrient as per treatment was sprayed at flower initiation stage (50 DAS) and pod development stage (72 DAS). Among hydrogel application treatments, application of 5 kg ha^{-1} hydrogel produced the highest seed (1746 kg ha^{-1}) and stover yield (2701 kg ha^{-1}). The maximum seed yield was recorded under foliar nutrient spray of F_2- urea 2%, which was comparable with the foliar nutrients spray of F_6- DAP 2% and F_3- thiourea 500 ppm. The remaining treatments i.e. F_1- water spray, F_4- Salicylic acid, F_5- NPK (19: 19: 19) 0.5% found to be significantly inferior than that of F_2- urea 2% for seed and stover yield.

Keywords: Hydrogel, foliar, spray, nutrients, chickpea, *Cicer arietinum* L.

Introduction

Chickpea (*Cicer arietinum* L.) is an important winter season pulse crop. It is a rich source of protein and plays an important role in human nutrition for large population in the developing world. Pulses contain a high percentage of quality protein nearly three times as much as cereals. Chickpea is valued for its nutritive seeds with high protein content (18-22%), carbohydrate (52-70%), fat (4-10%), minerals, calcium (Ca), phosphorus (P), iron (Fe) and vitamins. However, chickpea is a high protein yielding grain legume besides groundnut and soybean. One hundred grams of chickpea seeds provides 360 calories of energy. The high nutritional value makes chickpea an important food particularly in drought prone areas of the world. Chickpea can fix up to 140 kg N ha^{-1} in a growing period (Poonia and Pithia, 2013) [9] and leaves substantial amount of residual nitrogen for subsequent crops and adds plenty of organic matter to maintain and improve soil health and fertility.

India is one of the most important chickpea growing country in Asia with an area of 9698.75 thousand ha with the production of 11078.50 thousand tonnes and average productivity of 1142 kg ha^{-1}. Madhya Pradesh, Uttar Pradesh, Rajasthan, Maharashtra, Gujarat, Andhra Pradesh and Karnataka are the major chickpea producing states sharing over 95% area. Chickpea is an important winter season pulse crop in Chhattisgarh. In Chhattisgarh, chickpea is grown over an area of 381.77 thousand ha with an annual production of 88.19 thousand tonnes and an average productivity of 231 kg ha^{-1} (Anonymous, 2019-20) [1].

Chickpea is mainly cultivated with traditional methods under arid and semi-arid regions where shortage of water during crop growth period has become the major impediments for its cultivation. The stress crunch of inefficient use of rain and irrigation water by rainfed crops is the most important problem in semiarid and arid regions. Rainfed agriculture has a protruding role to play in India's agriculture and economy. Rainfed areas are home to the majority of rural poor and marginal farmers, who come across multiple risk 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. Under dryland/rainfed condition, application of water saving super absorbent polymers (SAP) i.e. hydrogel into the soil could be an effective way to increase both water and nutrient use efficiency in crops (Lentz *et al*., 1998) [6]. Hydrogel is generally drilled in the soil before sowing the crop, it is presumed that hydrogel retain large quantities of water and nutrients, which are released as and when required by the plant and it thus plant growth could be improved under limited water and nutrient supply (Gehring and Lewis, 1980) [3]. 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, stops erosion, water runoff and increase the soil aeration and microbial activity (Halagalimath and Rajkumara, 2017) [5].

Foliar application of nutrients has been proved to be an important asset of fertilizer application with the specific aim of increasing nutrient availability at the time of need. Though the emphasis has been laid down for foliar fertilization of trace elements yet it has repeatedly been observed that the foliar application of macronutrients too, had a positive impact on plant metabolism and ultimately on yields. The nitrogen supply can be maintained through foliar application at lower concentration by the bioregulators that act as chemical catalyst in plants and improves physiological and reproductive efficiency in the plant. These bioregulators possibly improve the gene expression for efficient sucrose transport and increases dry matter partitioning for grain production (Werdan *et al*., 1975) [11]. Nutrient management (major and minor) is the main component for sustainable chickpea production along with foliar application of water soluble fertilizer at appropriate stages of growth may also ameliorate the nutrient deficiency as well as mitigate the heat stress. Foliar application of urea has been found effective in increasing the nitrogen availability to developing seeds in pulses (Palta *et al*., 2005) [8], whereas thiourea, a sulphydryl compound plays a significant role in improving dry matter distribution for seed yield (Ghanshyam, 2000) [4]. Thiourea helps in better translocation of photosynthates from source to sink and also reduces the nitrate reductase activity. It contains 42% sulphur and 36% nitrogen and has been used so far chiefly for breaking dormancy and stimulating germination of seeds. Benficial effect of thiourea has been observed in pigeonpea, horsegram and mothbeen.

Materials and Methods

The experiment "Effect of hydrogel application and foliar spray of nutrients on growth yield and economics of chickpea (*Cicer arietinum* L.) Under limited irrigation supply" was conducted at Research cum Instructional Farm of IGKV, during rabi season of 2020-21. The climate of the region is sub-humid to semi-arid. The crop received 41.9 mm rainfall during the crop period. There was no rainfall in the month of December. Weekly Maximum relative humidity throughout the crop season varied between 77.57 to 89 per cent and weekly minimum relative humidity throughout the crop season varied between 20.42 to 54 per cent. The weekly values of evaporation ranged from 2.9 to 31.1 mm per day, whereas, sunshine values varied from 3.2 to 6.8 hours per day. The maximum temperature during the growth period varied between 28.2 to 33.6°C, whereas minimum temperature varied between 10.3 to 17.6°C. The soil was clayey, neutral in reaction (pH 7.10) having an organic carbon content of 0.57% and low amount of available nitrogen (167.50 kg ha^{-1}), medium phosphorus (18.12 kg ha^{-1}) and high potassium (312.31kg ha^{-1}) content. The test variety was Indira Chana-1. Chickpea variety Indira Chana-1 was sown on 30th November, 2020 and harvested on 25th March, 2021. During crop growth period various yield attributing characters like pods $plant^{-1}$, seeds pod^{-1}, 100 seeds weight, seed yield and stover yield were taken as per schedule and requirement of investigation.

Results and Discussion

Number of pods plant^{-1}

The application of hydrogel 5 kg ha^{-1} produced significantly higher no. of pods $plant^{-1}$ (39.75) as compared to without application of hydrogel. Moreover, lowest number of pods $plant^{-1}$ (37.30) was observed under without application of hydrogel. Similar results have been also reported by Boatright *et al.* (1997) and Shankarappa *et al.* (2020) [2, 10].

As regards to foliar nutrients spray, more number of pods $plant^{-1}$ (40.77) was observed under foliar nutrient spray of F_2- urea 2%. This treatment produced comparable number of pods to that of foliar nutrient spray of F_3- thiourea 500 ppm and F_6- DAP 2%. The remaining treatments were found to be inferior than foliar nutrient spray of F_2- urea 2%. The least number of pods $plant^{-1}$ (34.1) was found in treatment of water spray (control). Similar results have been also reported by Palta *et al.* (2005) and Singh *et al.* (2015) [8, 10]. Interaction effect of hydrogel and different foliar nutrients spray was found non-significant.

Number of seeds pod^{-1}

The application of hydrogel 5 kg ha^{-1} produced significantly higher number of seeds $plant^{-1}$ (1.56) as compared to without application of hydrogel. Moreover, lowest number of seeds $plant^{-1}$ (1.37) was observed under without application of hydrogel. Similar results have been also reported by Boatright *et al.* (1997) and Shankarappa *et al.* (2020) [2, 10].

In case of different treatments of foliar nutrients spray, the treatments showed significant variation in number of seeds pod^{-1}. The highest number of seeds pod^{-1} (1.6) was recorded under the treatment of foliar nutrient spray of urea 2% at flower initiation and pod development stage as compared to all other foliar spray treatment excepting foliar spray of thiourea 500 ppm and DAP 2% and least number of seeds pod^{-1} (1.3) was observed under F_1- water spray (control). This might be due to spray of urea which increases the translocation of assimilates to sink. Similar results have been also reported by Palta *et al.* (2005) and Singh *et al.* (2015) [8, 10]. Interaction effect of Hydrogel and different foliar nutrients spray was found non-significant.

100 seed weight (g)

The application of hydrogel 5 kg ha^{-1} significantly increased the 100 seed weight of chickpea as compared to without application of hydrogel. The maximum 100 seed weight of 25.69 g was observed under the application of hydrogel 5 kg ha^{-1} while, minimum 100 seed weight of 24.51 g was obtained under without application of hydrogel. This variation might be due to seed size and seed diameter which is genetic character of chickpea. Similar results have been also reported by Boatright *et al.* (1997) [2]. In case of different treatments of foliar nutrient spray, the treatments showed significant variation in 100 seed weight. The maximum 100 seed weight was observed in the treatment of 2% foliar spray of urea (26.21 g) which was at par with the foliar nutrient spray of F_6- DAP 2% and F_3- thiourea 500 ppm. The remaining treatments gave lower seed weight as compared to foliar nutrient spray of F_2- urea 2%. The minimum 100 seed weight (24.06) was observed under water spray (control). Similar results have been also reported by Palta *et al.* (2005) and Singh *et al.* (2015) [8, 10]. Interaction effect of hydrogel and different foliar nutrients spray was found non-significant.

Table 1: Yield of chickpea as influenced by hydrogel application and foliar spray of nutrients

Treatment	Number of pods plant^{-1}	Number of seeds pod^{-1}	100 seed weight (g)
Hydrogel application			
T_1 – 0 kg ha^{-1}	37.30	1.37	24.51
T_2 – 5.0 kg ha^{-1}	39.75	1.56	25.69
S.Em±	0.39	0.05	0.15
CD (P=0.05)	2.38	NS	0.90
Foliar spray of nutrients			
F_1: Water spray (control)	34.10	1.30	24.06
F_2: Urea 2%	40.77	1.60	26.21
F_3: Thiourea 500 ppm	39.8	1.50	25.71
F_4: Salicylic acid 100 ppm	37.37	1.40	23.04
F_5: NPK (19:19:19) 0.5%	38.83	1.43	25.62
F_6: DAP 2%	40.28	1.55	25.96
S.Em±	0.63	0.06	0.36
CD (P=0.05)	1.85	0.17	1.06
Interaction			
TXF	NS	NS	NS

Seed yield (kg ha^{-1})

The application of hydrogel 5 kg ha^{-1} produced the seed yield of 1746 kg ha^{-1}, which was significantly higher than without application of hydrogel (1535 kg ha^{-1}). The increase in seed yield due to application of hydrogel was to the extent of 13.74%. This variation was due to application of hydrogel. The increase in seed yield due to hydrogel application in different crops have been also reported by Boatright *et al.* (1997) and Shankarappa *et al.* (2020) [2, 10].

In case of foliar nutrient spray, significant variation was found in all treatments. The maximum seed yield (1780 kg ha^{-1}) was recorded under foliar nutrient spray of F_2- urea. This treatment produced comparable seed yield to that of foliar nutrient spray of F_6- DAP 2% and F_3- thiourea 500 ppm. The remaining treatments were found to be significantly inferior to that of foliar nutrient spray of F_2- urea. The minimum seed yield (1480 kg ha^{-1}) was obtained under the F_1- water spray (control). This might be due to the fact that foliar spray of nutrients increase the photosynthetic activities of plants, which in turn increase the active leaf surface during the grain filling period, facilitating the best partitioning of the source and sink and creating the congenial atmosphere in plants for enhancing the yield. Foliar spraying of urea retard the loss of chlorophyll and leaf nitrogen with increased photosynthetic ability resulting in enhanced seed yield. Similar observation was also reported by Mitra *et al.* (1987). Interaction effect of hydrogel and foliar nutrients spray was found non-significant.

Stover yield (kg ha^{-1})

The application of hydrogel 5 kg ha^{-1} produced the maximum stover yield (2701 kg ha^{-1}), which was significantly higher than without application of hydrogel. The lowest stover yield of 2388 kg ha^{-1} was observed in 0 kg ha^{-1} hydrogel application. Similar results have been also reported by Boatright *et al.* (1997) and Shankarappa *et al.* (2020) [2, 10].

In case of foliar nutrient spray treatment, the results showed significant variation among different treatments. The highest stover yield (2706 kg ha^{-1}) was recorded under treatment of foliar nutrient spray F_2- urea 2%, which was at par with the treatment of foliar nutrient spray of F_6- DAP 2% and F_3- thiourea 500 ppm. The remaining treatments produced significantly lower stover yield as compared to foliar nutrient spray F_2- urea 2%. The minimum stover yield (2397 kg ha^{-1}) was observed under the water spray (control). Interaction effect of hydrogel and foliar nutrients spray was found non-significant.

Table 2: Yield of chickpea as influenced by hydrogel application and foliar spray of nutrients

Treatment	Seed yield (kg ha^{-1})	Stover yield (kg ha^{-1})	Harvest index (%)
Hydrogel application			
T_1: 0 kg ha^{-1}	1535	2388	39.11
T_2: 5.0 kg ha^{-1}	1746	2701	39.25
S.Em±	**16.42**	**26.32**	**0.23**
CD (P=0.05)	**99.92**	**160.12**	**NS**
Foliar spray of nutrients: 6			
F_1: Water spray (control)	1480	2397	38.16
F_2: Urea 2%	1780	2706	39.66
F_3: Thiourea 500 ppm	1668	2571	39.35
F_4: Salicylic acid 100 ppm	1567	2446	39.07

F_5: NPK (19:19:19) 0.5%	1626	2509	39.33
F_6: DAP 2%	1724	2638	39.51
S.Em±	39.26	57.31	0.31
CD (P=0.05)	115.82	169.07	0.92
Interaction			
TXF	NS	NS	NS

Harvest index (%)

The data indicate non-significant difference due to the treatments of hydrogel application. While, significant variation was obtained among various foliar nutrient spray treatments. Similar results have been also reported by Boatright *et al.* (1997), Palta *et al.* (2005) [2, 8].

In case of different foliar nutrient spray treatments, the highest harvest index (39.66%) was recorded in of F_2- urea 2%, which was being at par to F_6 - DAP 2% and F_3- thiourea 500 ppm while, minimum harvest index was found under water spray (control). This might be due to higher accumulation of photosynthates and translocation of nutrients to economic part of the crop. Interaction effect of hydrogel and different foliar nutrients spray was non-significant.

Conclusion

The application of 5 kg ha^{-1} hydrogel produced the highest seed yield, stover yield as compared to without application of hydrogel under limited irrigation supply. The foliar nutrient spray of urea 2% at flower initiation and pod development stages, enhanced seed yield and stover yield, which was comparable with the foliar nutrient spray of DAP 2% and thiourea 500 ppm.

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