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Seed Priming Application of Gibberellic Acid on Growth, Biochemical, Yield Attributes and Protein Status of Chickpea (*Cicer arietinum* L. cv. DCP 92-3)

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Abstract

A pot experiment was conducted at a net house of the Department of Botany, Aligarh Muslim University, in the 'rabi' season of October, 2009 to March, 2010 to evaluate the effects of gibberellic acid (GA) on growth, physio-biochemical, yield and quality parameters of chickpea cultivar DCP 92-3. Surface sterilized seeds of chickpea (*Cicer arietinum* L.) were soaked in four concentrations viz., 0,10^{-7},10^{-6} and 10^{-5}M solution of GA for 4, 8, or 12 h and sown in pots. The potted plants were analysed at 90 and 100 days after sowing (DAS) for shoot length, leaf area (LA) per plant, and carbonic anhydrase (CA) activity. The pod number, seed yield per plant and protein content was estimated at harvest. All parameters were found to be significantly enhanced by different levels of GA, with stimulation being noted following a 8-h soaking treatment with 10^{-6}MGA. Moreover, the mentioned parameters were enhanced by 69.33%, 68.79%, and 87.06% respectively over the control at the 90 DAS stage. The pod number per plant, seed yield per plant and protein content were stimulated by 82.69%. 5.44% and 54.32% respectively.

Key Words: Dry weight, Leaf area, leaf chlorophyll content, carbonic anhydrase, seed yield, seed protein content

1. Introduction

Among pulses, for production, chickpea occupies the first position in India and third position at global level (FAO, 2012). It is very nutritive and used as a protein adjunct to starchy diets at global level. It is given as preventive diet to atherosclerosis patients because of its rich phosphorus (P) content. Also, it is an ingredient of a Unani-antihypersensitive drug ‘Ajmaloon’. Moreover, its cultivation helps in sustaining soil fertility by fixing nitrogen (N) up to 140 kilogram per hectare (kg/ha) per year (Rupela, 1987). This crop is grown on 8.21 million hectares of our country with the annual production of 7.48 million tonnes and average productivity of 911 kg/ha (FAO, 2012). There are several factors for low productivity of chickpea in our country. A few of these are described here (i) more than 75 % of Indian farmers own small or marginal holdings of less than two hectares,((ii) low or no use of fertilizers due to scarcity of funds (iii) generally, farmers are ignorant of precise doses of fertilizers recommended by the Agriculture Department for a particular cultivar and region, the techniques of cultivation of high yielding varieties, post-harvest technology and poor processing and storage facilities (iv) pest and diseases cause considerable losses (Patil *et al*., 2011).

To attain such goal, the use of GA may play an important role as this is known to affect many facets of plant life, including, seed germination, leaf expansion, P_N, gs, N-fixation, phloem loading, water and mineral uptake, assimilate translocation, harvest index (Gana, 2010). GA occupies a prominent position in mediating a variety of plant physiological processes including seed germination, leaf expansion, flower and fruit set, dry matter production, photosynthesis, translocation of food material and synthesis of mRNA coding for hydrolytic enzymes (Tiwari *et al.,* 2011). Moreover, the superiority of GA among the classical PGRs has also been substantiated in the author’s primitive studies also. GA is known to exert their effects with help of specific enzymes, the synthesis of which induce by influencing the translation and/or transcription (Huttly and Phillips, 1995). Hence, even though GA itself may be metabolized, its future positive and effective consequences remain apparent because of these enzymes. Therefore, the seed priming application of GA used before sowing may strongly alter the vegetative growth pattern during which the basic infra-structure of crop / its physiology and metabolic pathways, responsible for biosynthesis of important cell metabolites, is established. Keeping its prominent role in various physiological processes of plants, it is logical to exploit its potential by way of establishing its adequate level and soaking duration for pre-sowing seed treatment.

2. Materials and Methods

A pot experiment was conducted during the ‘rabi’ (winter) season of 2009-2010 on chickpea cultivar. The required number of pots was arranged according to a factorial randomized design. Just one day before the sowing, pots were irrigated lightly to provide necessary moisture for seed germination. The amount of GA was dissolved in 10 Ml ethyl alcohol and the final volume was made 100 Ml using DDW. Further dilutions of the stock solutions were made with DDW as per requirement. Four concentrations of aqueous solution of GA for pre-sowing seed treatment, viz. 0 (water), 10^{-7}, 10^{-6} and 10^{-5}M GA, constituted one variant and the three pre-sowing seed soaking durations, i.e. 4, 8 and 12 hours (h), the other. A uniform recommended basal dose of 40 kg N + 30 kg P_2O_5/ha (17.9 mg N+13.4 mg P/kg soil) was applied to all pots (Anonymous,1992), with the half dose of N and full dose of P giving at the time of sowing and the remaining half dose of N after 30 DAS. Diammonium phosphate was used as a common source for N and P. However, the remaining amount of N dose was compensated with urea. Finally, four plants per pot were maintained. A water-sprayed control was also included in the scheme of treatments. There were four replicates for each treatment. The pots were kept free from weeds and irrigated as and when required for better establishment. Subsequent irrigation was done two times a week to keep an optimum moisture level in the soil. Growth characters and physiological and biochemical characteristics were studied at 90 and 100 DAS while yield and quality parameters at harvest.

Length of shoot on per plant basis was determined separately with the help of a metre scale. The LA per plant was computed by using total leaf dry weight per plant and dry weight of those leaves for which the area was obtained. Activity of the CA was estimated by adopting the method of Dwivedi and Randhawa (1974).

Number of pods per plant was determined at physiological maturity from two remaining plants. The total seeds of two plants were threshed, cleaned and allowed to dry in the sun for some time and their weight was obtained with the help of an electronic balance, with expressing their weight on per plant basis. The total protein content in the dry seeds was estimated by adopting the methodology of Lowry *et al.* (1951). All data were analysed statistically adopting the analysis of variance technique, according to Gomez and Gomez (1984).Software *SPSS* 16.0 was also used for analyses.

3. Results

Interaction $S_{10}{}^{-6}{}_{M\ GA}\times S_{8h}$ gave the maximum value for shoot length per plant at 90 DAS, with its effect being at par with that of $S_{10}{}^{-6}{}_{MGA}\times S_{4h}$. Interaction $S_{10}{}^{-6}{}_{M\ GA}\times S_{8h}$ gave 69.33% higher value for shoot length per plant than the minimum value giving interaction $S_W\times S_{8h}$ at this stage. However, interaction effect on this parameter was not found significant at 100 DAS. Interaction $S_{10}{}^{-6}{}_{MGA}\times S_{8h}$ gave the maximum value of LA per plant at 100 DAS. Its effect was followed by that of $S_{10}{}^{-7}{}_{MGA}\times S_{8h}$ and $S_{10}{}^{-6}{}_{MGA}\times S_{4h}$ at this stage. Interaction $S_{10}{}^{-6}{}_{MGA}\times S_{8h}$ gave 68.79% higher value than the lowest value giving interaction $S_W\times S_{4h}$ at this stage. However, the effect of interaction treatments was not found significant at 100 DAS. Interaction $S_{10}{}^{-6}{}_{M\ GA}\times S_{8h}$ gave the maximum value of CA at both stages. Its effect was followed by that of $S_{10}{}^{-7}{}_{M\ GA}\times S_{8h}$ and $S_{10}{}^{-6}{}_{M\ GA}\times S_{4h}$ at 90 DAS and was, however, equalled by that of $S_{10\text{-}6M\ GA}\times S_{12h}$, $S_{10\text{-}6M\ GA}\times S_{4h}$ and $S_{10\text{-}6M\ GA}\times S_{12h}$at 100 DAS. Interaction $S_{10}{}^{-6}{}_{MGA}\times S_{8h}$ gave 87.06 and 76.76% higher value at 90 and 100 DAS respectively than the lowest value giving interaction $S_W\times S_{4h}$ (Table 1) . Interaction $S_{10}{}^{-6}{}_{M\ GA}\times S_{8h}$ gave the maximum value for pod number per plant, however, its effect was at par with that of $S_{10}{}^{-6}{}_{M\ GA}\times S_{4h}$. Interaction $S_{10}{}^{-6}{}_{M\ GA}\times S_{8h}$ gave 82.69% higher value than $S_W\times S_{12h}$ which gave the lowest value. The interaction effect on seed yield per plant was not found significant (Table 10). Interaction $S_{10\text{-}6M\ GA}\times S_{8h}$ gave the maximum protein value. Its effect was followed by that of $S_{10}{}^{-6}{}_{M\ GA}\times S_{12h}$ and $S_{10}{}^{-6}{}_{MGA}\times S_{4h}$. Interaction $S_{10}{}^{-6}{}_{M\ GA}\times S_{8h}$ increased the seed protein content by 26.01% over $S_W\times S_{12h}$ and by 54.32% over the least value giving combination $S_{10}{}^{-5}{}_{M\ GA}\times S_{8h}$ (Table 2) .

Table 1. Effect of concentrations (C) and durations of pre-sowing seed treatment (D) of GA on pod number per plant of cultivar DCP 92-3 of chickpea at harvest (mean of four replicates)

Soaking durations (S_h)	**Soaking concentrations ($S_{M\ GA}$)**				**Mean**
	S_W	**$S_{10^{-7}M\ GA}$**	**$S_{10^{-6}M\ GA}$**	**$S_{10^{-5}M\ GA}$**	
S_{4h}	17.20	18.47	22.80	17.50	18.99
S_{8h}	18.90	20.00	25.00	16.20	20.03
S_{12h}	19.84	20.20	23.45	19.23	20.68
Mean	18.65	19.56	23.75	17.64	
C.D. at 5%		C = 0.767	D = 0.886	C x D = 1.495	

Table 2. Effect of concentrations (C) and durations of pre-sowing seed treatment (D) of GA on seed yield per plant (g) of cultivar DCP 92-3 of chickpea at harvest (mean of four replicates)

Soaking durations (S_h)	**Soaking concentrations ($S_{M\ GA}$)**				**Mean**
	S_W	**$S_{10^{-7}M\ GA}$**	**$S_{10^{-6}M\ GA}$**	**$S_{10^{-5}M\ GA}$**	
S_{4h}	2.51	4.18	4.34	4.10	3.74
S_{8h}	2.52	4.27	4.47	4.21	3.87
S_{12h}	2.57	4.21	4.24	4.11	3.67
Mean	2.33	4.22	4.35	4.14	
C.D. at 5%		C = 0.150	D = 0.173	C x D = NS	

4. Discussion

The growth improving effect of pre-sowing seed treatment for 8h with 10^{-6}M GA over their respective water treated control on plant height and LA of cultivar of chickpea could be explained on the basis of its roles mentioned above and the fact that the supply of GA by pre-sowing seed treatment would more than compensate the ‘hidden hunger’ of growing crops for GA. These findings have been obtained by a number of workers including Khan and Samiullah (2003), Jafri (2009) and Thakare *et al.* (2011). The increase in CA activity can be attributes to the hormone-induced increase in transcription and/or translation of the gene that codes for CA (Sugiharto *et al.*, 1992) to its role in enhancing the permeability of membranes and absorption of nutrients (Taiz and Zeiger, 2010). These results are also in accordance with the data of earlier workers including Khan *et al.* (2009). The enhancing effect of pre-sowing seed treatment for 8 h with 10^{-6}M GA over their respective water treated control on CA and NR activities of DCP 92-3 cultivar of chickpea grown with the recommended basal dose of N and P is a noteworthy observation. This may also be attributed, as for growth characters, to its (GA) roles on one hand and compensation of the ‘hidden hunger’ for GA by its pre-sowing seed treatment on the other.

These results also corroborate the findings Jafri (2009) on NR activity for pre-sowing seed treatment (Fig 1&2).

The increased yield attributing parameters of treated plants, particularly pods per plant is likely to have contributed to the improved seed yield. This proposition is confirmed by correlation studies also wherein various yield characters may be noted to the positively and significantly correlated with seed yield. The observed increase in seed protein content due to pre-sowing seed treatment of GA is not surprising. An improvement in protein synthesis may result from the application of GA (Mozer, 1980) hence higher values for seed protein content (Fig 1 & 2). These results broadly corroborate with the findings of Khafagy (1995) on GA application.

5. Conclusion

The best concentration (10^{-6}M) and duration (8 h) of pre-sowing seed treatment of the selected PGR (GA) have been established for the optimum performance of the most promising cultivar of chickpea (DCP 92-3).

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