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Effect of growth regulators and nipping on Bio-chemical traits and yield attributes of chickpea (*Cicer arietinum* L.)

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Abstract
The treatment was comprised of foliar spray of naphthalene acetic acid (NAA), maleic hydrazide (MH) and nipping along with untreated control. NAA 50 ppm and MH 60 ppm concentrations and nipping were used in experimentation. Observations were recorded at 30, 50, 70 DAS and maturity. The observations had been studied on biochemical, yield and yield attributes parameters of the JG-14. Foliar spraying of naphthalene acetic acid, maleic hydrazide and nipping at 30 and 50 DAS were performed well. It is concluded from the result that foliar application of NAA 50 ppm at 30 and 50 DAS and nipping at 30 and 50 DAS were found increase the all parameters of plant like total chlorophyll content, nitrate reductase activity, protein content in seed, leaf nitrogen content, total phenol content, number of pod per plant, pod weight plant^{-1}, 100 number of seed plant^{-1}, seed weight plant^{-1}, grain yield (g) plant^{-1}, grain yield quintal hectare^{-1} and harvest index followed by foliar application of NAA 50 ppm at 30 DAS and nipping of shoot at 30 and 50 DAS respectively except plant height.

Keywords: NAA, Chlorophyll contents, Protein etc

Introduction
Chickpea is a main nutritive legume crop of rural and urban household of the poor in the developing countries. Chickpea is an economical source of quality protein of food. Chickpea has nitrogen fixation properties which is plays an important role in maintenance of the soil fertility, particularly in the arid and low rainfall areas as chickpea being cropped under crop rotation (Roy *et al.*, 2010) [12].Chickpea is also known as gram, Bengal gram, garbanzo bean, and sometimes known as Egyptian pea, *ceci*, *cece*or *chana*. Chickpea (*Cicer arietinum* L.) belongs to the family Leguminaceae is an important winter season pulse crop having extensive geographical distribution. Chickpea (*Cicer arietinum* L.) is an important pulse crop grown and consumed all over the world, especially in the Afro-Asian countries. Its protein quality is better than other legumes such as pigeon pea, black gram and green gram (Kaur and Singh, 2005) [5]. Chickpea contains protein 21%, carbohydrate 61%, fiber 3%, oil 4.8-5.5, calcium 0.2%, phosphorus 0.3%, ash 3%, and 0.12-0.33 mg riboflavin (Atul *et al*. 2011) [2]. Nipping in chickpea is one of the important techniques for the enhancement of yield. Nipping at various stages tended to enhance number of branches and number of pods that in turn boost chickpea yield (Aziz, 2002) [3]. Nipping practice in the research area has two fold advantage *i.e.* one hand nipping at prescribed growth stages could improve yield of the crop while on the other hand during time the chickpea in the field is usually a shortage of fodder and poor farmers could not afford to buy forage at distant locations, so chickpea may provide them an opportunity to fetch green fodder for their livestock.

Material and method
The site has sub-humid climate and falls in the Indogangeticplains having an alluvial soil and lies between latitude 26.47^0 North and at a longitude 82.12^0 East with an elevation of about 113 meters from sea levels and is subjected to extremes of weather conditions. The Student Instructional farm (SIF) is situated 42 km away from Faizabad. The weather conditions in terms of minimum and maximum temperature, relative humidity and rainfall, sunshine hours were recorded during the crop season *i.e.*, from October to March during 2015-2016.

The experiment was laid out in randomized block design with three replications. The plot size (6 rows, 3 meter long) 3.0 m x 1.8 m and the spacing was 30 cm x 10 cm (row x plant). The experimental field was properly leveled followed by preparatory irrigation afterward at optimum tilth, the field was ploughed and layout was done as per programme. Ridges and furrows were made as per distance required for chickpea variety. Nitrogen, phosphorus, potassium and sulphur were applied in the ratio of 20:40:20:20 as basal dose through urea, single superphosphate, murate of potash and sulfex-80-WP, respectively. Solution of NAA 50 ppm and maliec hydrazide 60 ppm were prepared at 30 days after sowing and 50 days after sowing and sprayed on the foliage of plants with the help of hand sprayer "Ganesh" as per treatment.

The leaf temperature was measured by plant efficiency analyzer (SPAD). It were taken at 45, 65, 85 day after sowing (DAS). Chlorophyll and nitrogen content: (SPAD value): Microprocessor Based Plant Efficiency Analyzer (Model: X55/M-PEA). Nitrate reductase activity was assayed according to the method of Jaworski (1971), and expressed as µ g nitrite produced g^{-1} fresh weightha^{-1}. Total protein content was estimated by using method of Lowery *et al.* 1951. For the estimation of total phenols present in plant samples was done by method of Bray & Thorpe (1964).

Statistical Analysis

Data recorded on various growth and yield attributes were subjected to statistical analysis by Fisher method of analysis of variance (Fisher and Yates 1949).

Result and Discussion

Chlorophyll content in leaf (SPAD value):

The data pertaining to total chlorophyll content in leaf under various treatments are presented in Table-1. At 30 DAS chlorophyll content was increase non-significantly in all treatments over the control.

Table 1: Effect of growth regulators and nipping on chlorophyll content (SPAD value) of chickpea at different growth stages

Treatments	Chlorophyll content (SPAD value)		
	30 DAS	50 DAS	70 DAS
T_1- Control- No nipping and FADW at 30 & 50 DAS	11.39	10.00	8.53
T_2- Nipping of shoots (NS) at 30 DAS (2-3 cm)	11.51	10.37	9.20
T_3- NS at 30 and 50 DAS (2-3 cm)	11.50	10.60	9.37
T_4- FA ofNAA 50 ppm at 30 DAS	11.40	10.50	9.53
T_5- FA ofNAA 50 ppm at 30 and 50 DAS	11.30	10.63	9.60
T_6- FA of MH 60 ppm at30DAS	11.34	10.27	8.73
T_7- FA of MH 60 ppm at30 and 50DAS	11.32	10.30	8.93
SEm±	0.26	0.10	0.18
CD at 5%	NS	0.29	0.57

At 50 DAS out of the seven treatments, the highest chlorophyll content was recorded in foliar application of NAA 50 ppm at 30 and 50 DAS (T_5) and foliar application of NAA 50 ppm at 30 DAS (T_4), nipping of shoot at 30 and 50 DAS (T_3) and nipping of shoots at 30 DAS (T_2) showed significant differences over the control. However, minimum chlorophyll was recorded with foliar application of MH 60 ppm at 30 DAS (T_6), but it was higher in comparison to control. Same trend were also found at 70 DAS. The similar result was found by Ramesh *et al.* (2014) reported that the biochemical parameters namely, chlorophyll content was observed to increase significantly with application of NAA (20 ppm).

Leaf nitrogen content (SPAD value)

The data pertaining to nitrogen content in leaf under various treatments are presented in Table-2. At 30 DAS nitrogen content was increase non-significantly with in all treatments over the control. The significant increase in leaf nitrogen content at 50 DAS was observed in foliar application of NAA 50 ppm at 30 and 50 DAS (T_5) which was at par with foliar application of NAA 50 ppm at 30 DAS (T_4), nipping of shoot at 30 and 50 DAS (T_3), nipping of shoot at 30 DAS (T_2) and the foliar application of maleic hydrazide 60 ppm at 30 and50 DAS (T_7).

Significant increase in leaf nitrogen content at 70 DAS was recorded withfoliar application of NAA 50 ppm at 30 and 50 DAS (T_5) which was at par with foliar application of NAA 50 ppm at 30 DAS (T_4), nipping of shoot at 30 and 50 DAS ($T`_3$) and nipping of shoot at 30 DAS (T_2).More ever, the minimum nitrogen content in leaf was recorded with foliar application of MH 60 ppm at 30 DAS (T_6) but it was higher over the control. Similar result was found by Senthil*et al*. (2003), that the foliar application of salicylic acid (100 ppm), NAA (40 ppm)

Table 3: Effect of growth regulators and nipping on nitrogen content (SPAD value) of chickpea leaf at different growth stages

Treatments	Leaf nitrogen content		
	30 DAS	50 DAS	70 DAS
T_1- Control- No nipping and FADW at 30 & 50 DAS	0.49	0.53	0.42
T_2- Nipping of shoots (NS) at 30 DAS (2-3 cm)	0.49	0.57	0.45
T_3- NS at 30 and 50 DAS (2-3 cm)	0.50	0.58	0.46
T_4- FA ofNAA 50 ppm at 30 DAS	0.48	0.59	0.47
T_5- FA ofNAA 50 ppm at 30 and 50 DAS	0.49	0.60	0.49
T_6- FA of MH 60 ppm at30DAS	0.48	0.54	0.42
T_7- FA of MH 60 ppm at30 and 50DAS	0.49	0.56	0.44
SEm±	0.01	0.01	0.01
CD at 5%	NS	0.04	0.04

Enzymatic activity

Nitrate reductase

The mean data of nitrate reductase under (µ g nitrite produced g^{-1} fresh weight h^{-1}) various treatments have been presented in Table-4. All the treatments show a non-significant increase in nitrate reductase activity at 30 DAS of observations with respect to control.

Table 4: Effect of growth regulators and nipping on NR activity (µ g nitrite produced g^{-1} fresh weight h^{-1}) of chickpea

Treatments	Nitrate reductase activity		
	30 DAS	50 DAS	70 DAS
T_1- Control- No nipping and FADW at 30 & 50 DAS	122.73	165.18	184.71
T_2- Nipping of shoots (NS) at 30 DAS (2-3 cm)	122.86	169.10	190.24
T_3- NS at 30 and 50 DAS (2-3 cm)	121.25	170.10	191.10
T_4- FA ofNAA 50 ppm at 30 DAS	121.80	171.55	192.83
T_5- FA ofNAA 50 ppm at 30 and 50 DAS	122.48	173.47	194.05
T_6- FA of MH 60 ppm at30DAS	121.23	166.84	186.39
T_7- FA of MH 60 ppm at30 and 50DAS	121.26	168.06	187.21
SEm±	0.58	1.48	1.01
CD at 5%	NS	4.57	3.12

Significant increase in nitrate reductase activity at 50 DAS was recorded with treatment foliar application of NAA 50 ppm at 30 and 50 DAS (T_5) which were at par with foliar application of NAA 50 ppm at 30 DAS (T_4), nipping of shoot at 30 and 50 DAS (T_3) and Nipping of shoots at 30 DAS (T_2). However the minimum increase in nitrate reductase activity was recorded in foliar application of MH 60 ppm at 30 DAS (T_6) but is was higher in respect to control (T_1). Mubeen *et al.* (2015) [8] similar reported that the response of seed priming and foliar application on plant growth regulators (GA_3), NAA and osmotic chemical KNO_3 as well as seed inoculation with *Rhizobium* culture was studied on Narendra Mung-1.

Protein content

The data pertaining to the protein content in seeds under the various plant growth regulators and nipping treatments are presented in Table-5. The significant increase in protein content was recorded with foliar application of NAA 50 ppm at 30 and 50 DAS (T_5) which were at par with foliar application of NAA 50 ppm at 30 DAS (T_4), nipping of shoots at 30 and 50 DAS (T_3), nipping of shoots at 30 DAS (T_2) and foliar application of MH 60 ppm at 30 and 50 DAS (T_7). However, lowest increase was noted in foliar application of MH 60 ppm at 30 DAS (T_6) over all the treatments but it was higher in comparison to control (T_1).

Table 5: Effect of growth regulators and nipping on protein content in seed of chickpea

Treatments	Protein content in seed (%)
T_1- Control- No nipping and FADW at 30 & 50 DAS	20.70
T_2- Nipping of shoots (NS) at 30 DAS (2-3 cm)	21.53
T_3- NS at 30 and 50 DAS (2-3 cm)	21.68
T_4- FA ofNAA 50 ppm at 30 DAS	22.06
T_5- FA ofNAA 50 ppm at 30 and 50 DAS	22.24
T_6- FA of MH 60 ppm at30DAS	21.42
T_7- FA of MH 60 ppm at30 and 50DAS	21.51
SEm±	0.26
CD at 5%	0.80

Effect of growth regulators and nipping on total phenol content

The data pertaining to the total phenol content in chickpea leaves under the various plant growth regulators and nipping treatments are presented in Table-6. The maximum increase in total phenol content at 50 DAS was recorded non-significant in respect to all over treatments. At 70 DAS the significant increase in total phenol content was recorded with treatment foliar application of NAA 50 ppm at 30 and 50 DAS (T_5) which was at par with foliar application of NAA 50 ppm at 30 DAS (T_4), nipping of shoots at 30 and 50 DAS (T_3), foliar application of MH 60 ppm at 30 and 50 DAS (T_7) and foliar application of MH 60 ppm at 30 DAS (T_6). However, lowest increase was noted in nipping of shoots at 30 DAS (T_2) over all the treatments. Similar result was found by Naz*et al.* (2008) reported that the combination of BAP and 2,4-D or NAA on chickpea.

Table 6: Effect of growth regulators and nipping on phenol content in leaf (mg/g) of chickpea

Treatments	Total Phenol Content	
	50 Days	70 Days
T_1- Control- No nipping and FADW at 30 & 50 DAS	0.454	0.522
T_2- Nipping of shoots (NS) at 30 DAS (2-3 cm)	0.433	0.518
T_3- NS at 30 and 50 DAS (2-3 cm)	0.427	0.541
T_4- FA ofNAA 50 ppm at 30 DAS	0.495	0.543
T_5- FA ofNAA 50 ppm at 30 and 50 DAS	0.545	0.556
T_6- FA of MH 60 ppm at30DAS	0.479	0.538
T_7- FA of MH 60 ppm at30 and 50DAS	0.467	0.540
SEm±	0.03	0.01
CD at 5%	NS	0.02

Yield and yield contributing traits at maturity

Grain yield (g) plant^{-1}

The data on seed yield (g) per plant have been presented in Table-7. The data on grain yield (g) per plant was recorded maximum in foliar application of NAA 50 ppm at 30 and 50 DAS (T_5) which were at par with FA of NAA 50 ppm at 30 DAS (T_4), nipping of shoots at 30 and 50 DAS (T_3), nipping of shoots at 30 DAS (T_2) and foliar application of MH 60 ppm at 30 and 50 DAS (T_7). However, lowest increase was recorded with foliar application of MH 60 ppm at 30 DAS (T_6) over all the treatments but it was higher in comparison to control (T_1).

Grain yield (kg) 2.4 m^2

The data on grain yield (kg) per plot have been presented in Table-7. All the treatments showed a significant increase in grain yield per plot over the control. The maximum grain yield per plotwas recorded with foliar application of NAA 50 ppm at 30 and 50 DAS (T_5) which was at par with foliar application of NAA 50 ppm at 30 DAS (T_4). However, the minimum grain yield per plot recorded with foliar application of MH 60 ppm at 30 DAS (T_6) over all the treatments but it was higher in comparison to control (T_1).

Grain yield (q) ha^{-1}

Seed yield of chickpea quintal ha^{-1} have been presented in Table-7. Mean data showed a significant increase in all the treatments over the control. The maximum grain yield (q) ha^{-1}was recorded with foliar application of NAA 50 ppm at 30 and 50 DAS (T_5) which was at par with foliar application of NAA 50 ppm at 30 DAS (T_4). Whereas, the minimum grains yield (q) ha^{-1} was recorded with foliar application of MH 60 ppm at 30 DAS (T_6) over all the treatments but it was higher in comparison to control (T_1).

Table 7: Effect of growth regulators and nipping on grain yield and harvest index of chickpea

Treatments	Grain yield (g) plant^{-1}	Grain yield/ 2.4 m^2 (Kg)	Biological Yield/2.4 m^2 (kg)	Grainyield (q ha^{-1})	Harvest index (%)
T_1- Control- No nipping and FADW at 30 & 50 DAS	12.89	0.40	1.50	16.67	27
T_2- Nipping of shoots (NS) at 30 DAS (2-3 cm)	13.80	0.48	1.58	20.00	30
T_3- NS at 30 and 50 DAS (2-3 cm)	14.29	0.49	1.59	20.42	31
T_4- FA ofNAA 50 ppm at 30 DAS	14.68	0.50	1.60	20.97	32
T_5- FA ofNAA 50 ppm at 30 and 50 DAS	14.99	0.54	1.63	22.36	33
T_6- FA of MH 60 ppm at30DAS	13.05	0.43	1.53	17.91	28
T_7- FA of MH 60 ppm at30 and 50DAS	13.70	0.46	1.56	19.03	29
SEm±	0.57	0.01	0.02	0.62	2.92
CD at 5%	1.77	0.04	0.07	1.90	NS

Note: FADW- Foliar application of distilled water, NS- Nipping of shoots, FA- Foliar application, MH- Maleic hydrazide, NAA- Naphthalene acetic acid and DAS- Days after sowing, PM- Physiological Maturity.

Biological Yield (kg) plot.$^{-1}$

The data on Biological yield (kg) per plot have been presented in Table-7. All the treatments showed a significant increase in biological yield per plot over the control. The maximum biological yield per plot was recorded with foliar application of NAA 50 ppm at 30 and 50 DAS (T_5) which was at par with foliar application of NAA 50 ppm at 30 DAS (T_4), nipping of shoot at 30 and 50 DAS (T_3) and nipping of shoot at 30 DAS (T_2). Whereas, the minimum biological yield per plot recorded with foliar application of MH 60 ppm at 30 DAS (T_6) over all the treatments but it was higher in comparison to control (T_1).

Harvest Index (%)

It is evident from the data presented in Table 7. Maximum harvest index was recorded with foliar application of NAA 50 ppm at 30 and 50 DAS (T_5), followed by foliar application of NAA 50 ppm at 30 (T_4). Whereas, the lowest harvest index was recorded with foliar application of MH 60 ppm at 30 DAS (T_6) over all the treatments but it was higher in comparison to control (T_1). The similar result was also found by Aslam *et al.* (2010) concluded that plant growth regulator (NAA) with 80% available soil moisture depletion level may be better to achieve higher seed yield and yield components in chickpea.

Summary and conclusion

The treatments consisted with nipping and NAA 50 ppm, maleic hydrazide 60 ppm, along with untreated control. Solutions of plant growth regulators were prepared on weight by volume basis in desired concentration. The seeds of chickpea variety JG-14 were sown and after germination of seeds, thinning was done at 20 DAS to maintain proper distance and population in each plots and weeding was done as per requirement to control the weeds. Solutions of different plant growth regulators were prepared at the time of foliar spray, while untreated control was sprayed with distilled water. Biochemical changes *i.e.*, chlorophyll content in leaves, nitrogen content in leaves and nitrate reductase activity in leaves were studied at 30, 50 and 70 DAS and total phenol content were studied at 50 and 70 DAS, while protein content was determined in mature seed, finally their effects were evaluated with yield and yield components.

Overall, it was observed that the application of naphthalene acetic acid 50 ppm at 30 and 50 DAS (T_5) was found most effective for increasing the total chlorophyll, nitrate reductase, protein content in seed, total phenol content, number of pods per plants, pods weight per plants, number of seeds per plant, seed weight per plants, 100 seed weight, seed yield (g) per plant and seed yield q ha^{-1}.

Thus, it can be concluded that foliar application of NAA 50 ppm at two times favoured overall improvement in characters which were highly linked with yield.

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