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Effect of Plant Growth Hormones on the Yield of Chickpea

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ABSTRACT

This paper explores the contribution of plant growth hormoneson yield and yield components of chickpea under an agro climatic condition of Rajshahi region in Bangladesh.The experiment was laid out by CompleteRandomized Design (CRD) for BARI Chhola-9 a variety of chickpea to observethe responses offive plant growth hormones (PGH) like GA_3, BAP, KN, NAA and IAA each with three (10. 30 and 50 ppm) treatments. Number of plants unit area^{-1}, number of effective pods plant $^{-1}$, number of non-effective pods plant^{-1}, 1000-grain weight, grain yield, stover yield, biological yield and harvest index were found statistically significant within PGH treatments. Theother parameters plant height, number of branches plant^{-1}, total pods plant^{-1}, number of seeds pod^{-1} and length of the pod werenon-significantly influenced when PGHs treated. Among the five growth hormones used here, GA_3 gave the highest performance and BAP produced the lowestfor yield contributing parameters of BARI Chhola-9. Among three levels ofGA_3, 30 ppm gave the highest yield contributing characters. The lowest result was obtained in 50 ppm BAP application. This experiment suggested that PGH would be a factor to increase yield in the modern agro farming and GA_3 will be used for getting more production of chickpea.

Key words: Chickpea, GA_3, Plant growth hormone, Rajshahi region, Yield

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1. INTRODUCTION

In Bangladesh, chickpea (*Cicer arietinum L.*) is the third major pulse crop after grass pea and lentil (Hasanuzzaman et al., 2007) and ranked fifth in the area and production but second in the consumption priority (BBS, 2010). Chickpea contributes about 3.87 % of total pulse cultivation in Bangladesh (BBS, 2013). The production of chickpea in the recent year 2015-2016 is 5947 MT and yield is 349 kg ha^{-1} under the 6886.53 hectare of area (BBS, 2016). Chickpea is the one of sources of dietary protein and other essential micronutrients for the majority of the people of Bangladesh. It is a protein-rich supplement to cereal-based diets, especially to the poor consumers in developing countries. Chickpea plays an important role in the agro-economy and human health of Bangladesh. Climate and soil are favorable for successfully chickpea production in Bangladesh but the yield of chickpea in Bangladesh is lower than other chickpea growing countries in the world mainly due to the use of traditional or low yielding varieties as well as adoption of

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poor management practices. Farmers of our country disparage to cultivation chickpea because they are getting attracted towards cash crops for better return and lower risk. Now a day the use of chickpea is growing very fast but the production is not sufficient to meet the increasing demand of our population. Bangladesh Agricultural Research Institute (BARI) have released several improved varieties of chickpea viz, BARI chhola- 1 to BARI chhola- 9 that are mainly cultivated in Bangladesh of which BARI chhola- 9 is the latest variety until now and this variety is most popular for the barind region's farmer (BARI, 2016).

The term plant growth hormones (PGH) cover the broad category of organic compounds which influence the plant growth when applied in very minute quantity (Hernandez, 1997; Ashraf et al., 1987; 1989). It also plays an essential role in many aspects of plant growth and development (Patil et al., 1987). The impact of PGHs in manipulating physiological processes in crop production and also developmental and yield suppression. The use of plant growth hormones in the field of agriculture has become commercialized in our country like some advanced counties like as Europe, USA and Japan. Many field experiment on various pulse crops show yield benefits from PGHs application. Literature shows that PGHs i.e., auxins, cytokinins and gibberellins are involved in plant growth, crop yield including cell division, cell enlargement, flowering, fruiting and seed formation of chickpea production (Mostofa et al., 2011). Auxin is the first identified plant hormone and two principle hormones in auxin group areindole-3-acetic acid (IAA) and naphthalene acetic acid (NAA) involved a wide variety of growth and developmental process in pulse crop (Davies, 1987). Commonly used cytokinins are 6-benzylaminopurine (BAP) and kinetins (KN) are used to promote growth and development. BAP is a first-generation synthetic cytokinin is widely used to enhance in cell division and shoot regeneration (Chawla, 2009). It spurs plant growth, sets blossoms, and improves fruit quality. KN stimulate cell division and also promote cell elongation. Gibberellic acid grade III(GA_3) from gibberellin group are the most essential hormones produces bigger leaves and longer stems, enhances photosynthesis, stimulates seed germination and triggers transitions from the vegetative to the flowering stage. The use of GA_3 play an important role in plant life including seed germination, life expansion, N-fixation, phloem loading, water and mineral uptake, assimilate translocation and harvest index of chickpea plant (Gana, 2010).

Bangladesh has succeeded in increasing chickpea production through sustained research and development efforts by selection of high yielding varieties of chickpea and but limited works regarding the effect of growth regulators on pulses has been carried out in scientific world or in Bangladesh. The success was made possible due to the cooperative work of farmers and researchers and commitment of researchers, extension worker and farmers. Due to the increasing demands and wide adaptability, pulse research is now driving more international attention. But a very limited work has been carried out on this aspect. Therefore, considering all the factors, a comprehensive study is needed to find out to evaluate the comparing performance of different plant growth hormones at different levels and to isolate the optimum level of plant growth hormones giving best performance on plant, growth, development and production of BARI Chhola-9 on the field condition.

2. MATERIALS AND METHODS

This field experiment was carried out at the researchfield under Department of Agronomy and Agricultural Extension in University of Rajshahi during the Rabi season from December 2015 to April 2016. Land type of experimental field was flat and well drained. The soil pH was 7.56.The experiment was carried out on chickpea variety BARI Chhola-9 and treatments included in the five plant growth hormones (PGH) each with three levels. Among the plant growth hormones, two hormones were Auxin i.e.,Indole-3-acetic acid (IAA) and Naphthalene acetic acid (NAA), two hormones were Cytokinin i.e., Kinetin (KN) and 6-Benzylaminopurine (BAP) and one hormone is Gibberellin i.e., Gibberellic acid grade III (GA_3). Three concentrations of those PGHs applied as treatments were 10 ppm, 30 ppm and 50 ppm for each PGH. All the plant growth hormones were applied one time at the field as per experimental specification 40 days after sowing (DAS)as foliar spray. No PGH application considered as control.

The experiment was laid out in a Complete Randomized Deign (CRD) with three replications. The total number of unit plots was 16 treatments x 3 replications = 48 plots. The experimental unit plot size was 2m X 2m = 4 m^2. The replication to replication distance 1.0 m, plot to plot distance 0.5 m and row to row distance 40 cm. The treatments were randomly assigned in each plot within a replication. The experimental plot was opened on 2th December 2015 with a power tiller and it was made ready for sowing on 8th December 2015by subsequently 3 to 4 ploughing and cross ploughing with a country plough followed by laddering. The each and every plot was fertilized with urea 40 kg ha^{-1}, TSP 80 kg ha^{-1}, MOP 30 kg ha^{-1}, boric acid 10 kg ha^{-1} and cow dung compost fertilizer 5 kg ha^{-1} were applied in the field at the time of final land preparation. The seeds were sown in the field on 8th December 2015 by line sowing method. The spacing between lines was 25cm. Seed rate was used 20g per m^2. Depth of the seed sowing in each plot was 3-4cm.Weeding was done with the help of hand hoe on 27thDecember 2015 (20 DAS) and 11thJanuary 2016 (35 DAS) with the help of hand hoe (nirani). Thinning was done to obtain optimum plant population. Irrigation was applied in the experimental field in one time on 1th January 2016at 25 DAS. To keep the field free from fungal disease infestation sprayed Cupravit @ 3 kg ha^{-1}. *Fusarium oxysporum*was a causal organism of fungal disease.Randomized procedure was followed to collect the data on yield attributing characters. Five plants were randomly selected and uprooted prior to maturity from each unit plot excluding border rows for data recording. After sampling, the crop from each unit plot (1m^2) was harvested at fully maturity on 13th April 2016

to record the data on grain and straw yields. The recorded data were compiled and tabulated for Analysis of Variance (ANOVA), was done by computer package program MSTAT. The mean differences among the treatments were adjusted by Duncan's New Multiple Range Test (DMRT).

3. RESULTS AND DISCUSION

The experimental plant chickpea var. BARI chhola-9 used in the experiment and the responses in the yield and yield components evaluated using five plant growth hormones (IAA, NAA, BAP, KN and GA_3) each with three levels (10, 30 and 50 ppm) where no PGH was control treatment. The effects of different treatments (plant growth hormones levels) on various yield parameters are presented in Table 1, which are discussed in the following sections.

3.1Plant height

Plant height was non-significantly influenced by different plant growth hormones levels at the time of final harvest. Although plant height (cm) was non-significant but numerically GA_3 gave the highest (67.27 cm) value in plant height, was produced by 30 ppm GA_3 level. BAP hormone showed the lowest (54.61 cm) value in plant height that was produced by 50 ppm BAP level. The PGH treatments showed the considerable values in the plant height (Table 1). Thomas & Katterman (1986) who reported that foliar spray of GA_3 increased the height (16%) of celery plants (*Apium graveolens* var. Dulce). The statement of Mishriky et al. (1990) was similar on the production of celery. He stated that foliar application of GA_3 (25 or 50 ppm) increased the plant height.

3.2 Number of branches per plant

No remarkable differences were observed in number of branches plant^{-1} influenced by different PGHs used at the time of final harvest (Table 1). Numerically among the five growth hormones levels, the highest (33.00) number of branches plant^{-1} was obtained from 50 ppm GA_3 level and the lowest (18.11) number of branches plant^{-1}was obtained from 50 ppm BAP level. Vasudevan et al. (2008) observed a significant increase in number of productive branches in Fenugreek plant sprayed with GA_3 (100 ppm) as foliar spray that resulted50% flowering.

3.3 Total pods, effective pods and non-effective pods per plant

Number of total pods plant^{-1} was non-significantly influenced by different PGHs levels but number of effect on both effective and non-effective pods plant^{-1} was significantly influenced (Table 1). The coefficient of variation was 25.46% for effective pods plant^{-1} and highly significant was 41.87% for non-effective pods plant^{-1}. GA_3 including three doses, hormonal effect was found to be highest (55.78) for number of total pods plant^{-1} in which highest (53.56) for number of effective pods plant^{-1} and lowest (2.22) for number of non-effective pods plant^{-1} was obtained at the 30 ppm GA_3 level. The lowest (49.80) number of total pods plant^{-1} in which lowest (46.02) number of effective pods plant^{-1} and highest (3.78) for number of non-effective pods plant^{-1} was obtained at 10 ppm GA_3 level.

In case of NAA, the number of total pods plant^{-1} was highest (47.78) including highest (43.56) number of effective pods plant^{-1} and lowest (4.22) number of non-effective pods plant^{-1} was obtained at50 ppm NAA level. The number of total pods plant^{-1} was lowest (45.89) including lowest (41.22) number of effective pods plant^{-1} and highest (4.67) number of non-effective pods plant^{-1} was produced by 10 ppm NAA level. IAA produced highest (44.11) number of total pods plant^{-1} including highest (39.33) number of effective pods plant^{-1} and lowest (4.78) number of non-effective pods plant^{-1} got at10 ppm IAA level. The lowest (41.00) number of total pods plant^{-1} including lowest (35.33) number of effective pods plant^{-1} and the highest (5.67) number of non-effective pods plant^{-1} got at50 ppm IAA level(Table 1).

For KN the number of total pods plant^{-1} was highest (39.89) in which highest (34.00) number of effective pods plant^{-1} and lowest (5.89) number of non-effective pods plant^{-1} was obtained from 50 ppm KN level. The number of total pods plant^{-1} was lowest (38.00) in which lowest (31.01) number of effective pods plant^{-1} and highest (6.99) number of non-effective pods plant^{-1} was produced by 10 ppm KN level. BAP produced highest (35.74) number of total pods plant^{-1} among them highest (27.96) number of effective pods plant^{-1} and lowest (7.78) number of non-effective pods plant^{-1} achieved from 10 ppm BAP level (Table 1). The lowest (31.55) number of total pods plant^{-1} among them lowest (19.66) number of effective pods plant^{-1} and the highest (11.89) number of non-effective pods plant^{-1} got from 50 ppm BAP level. The control level whereas no hormones doses were applied, shows the number of total pods plant^{-1}was 34.92, number of effective pods plant^{-1} was 29.70 and number of non-effective pods plant^{-1} was 5.22. Jahan & Adam (2013) investigated that, NAA effect on BARI Gom 26 increases number of effective tillers significantly only due to application of 50 mg/l NAA and the increases was 12.24% higher over the control, respectively. Non-effective tillers per plant decreased with all concentrations of NAA application and the maximum decreased (60.20%) was recorded with 50 mg/l NAA.

3.4 Number of seeds per pod

The number of seeds pod^{-1} was non-significantly influenced by different level of potassium PGHs used at different doses. We also found that in between all the treatments the highest (2.00) number of seeds pod^{-1} was recorded from Gibberellin group hormone GA_3 at 30 ppm level and the lowest (1.40) number of seeds pod^{-1} was recorded from control level, that mean no hormones applied here. Yadev & Bharud, (2009) reported that effect of 10 ppm GA_3 and 20 ppm NAA on Kabuli chickpea variety 'Virat' improved all yield components such as number of pods plant^{-1}, number of seeds

Table 1: Effect of different plant growth hormone levels on the yield and yield contributing characters.

PGH levels	Plant height (cm)	No. of branches plants^{-1}	No. of Total pods plant^{-1}	No. of effective pods plant^{-1}	No. of non-effective pods plant^{-1}	No. of seeds pod $^{-1}$	Length of the pod (mm)	1000-grain weight (g)	Grain yield (t ha^{-1})	Stover yield (t ha^{-1})	Biological yield (t ha^{-1})	Harvest index (%)
Control	57.54	19.44	34.92	29.70bcd	5.22bc	1.40	1.63	160.53bc	1.97b	2.95b	4.92bc	23.23bcd
10 ppm IAA	63.82	28.44	44.11	39.33abcd	4.78bc	1.67	1.61	168.68bc	2.41ab	3.61ab	6.02abc	36.11abcd
30 ppm IAA	62.95	28.33	42.63	37.41abcd	5.22bc	1.67	1.63	165.39bc	2.35ab	3.55ab	5.90abc	35.43abcd
50 ppm IAA	59.73	26.67	41.00	35.33bc	5.67bc	1.67	1.72	165.89bc	2.35ab	3.53ab	5.88abc	35.28abcd
10 ppm NAA	59.30	26.89	45.89	41.22abc	4.67bc	1.44	1.60	166.82bc	2.50ab	3.75ab	6.26ab	36.28abc
30 ppm NAA	61.11	26.78	46.00	41.45abc	4.55bc	1.68	1.73	168.74bc	2.54ab	3.82ab	6.36ab	37.25ab
50 ppm NAA	60.53	24.33	47.78	43.56abc	4.22bc	1.59	1.58	167.88bc	2.53ab	3.79ab	6.32ab	36.72ab
10 ppm KN	64.55	29.11	38.00	31.01bcd	6.99ab	1.78	1.88	160.35bc	2.00b	3.01b	5.01bc	25.15abcd
30 ppm KN	60.22	23.45	38.60	32.15bcd	6.45ab	1.82	1.89	160.43bc	2.02b	3.03b	5.04bc	30.44abcd
50 ppm KN	59.09	22. 00	39.89	34.00bc	5.89bc	1.67	1.78	164.78bc	2.22b	3.43b	5.65bc	31.01abcd
10 ppm BAP	57.58	21.00	35.74	27.96bcd	7.78ab	1.59	1.59	158.63bc	1.95b	2.93b	4.88bc	23.96bcd
30 ppm BAP	56.33	20.22	33.15	24.60cd	8.55ab	1.57	1.54	157.73c	1.78b	2.67b	4.44bc	22.03cd
50 ppm BAP	54.61	18.11	31.55	19.66d	11.89a	1.55	1.52	156.27c	1.52c	2.28c	3.79c	21.62d
10 ppm GA_3	62.78	30.22	49.80	46.02ab	3.78bcd	1.89	1.94	171.40bc	2.62ab	3.92ab	6.54ab	38.25ab
30 ppm GA_3	67.27	31.00	55.78	53.56a	2.22c	2.00	1.98	180.89a	2.68 a	4.03a	6.72a	40.41a
50 ppm GA_3	64.55	33.00	51.16	47.78ab	3.38bcd	1.78	1.91	175.33ab	2.63ab	3.95ab	6.60ab	39.41ab
LS	NS	NS	NS	0.05	0.05	NS	NS	0.05	0.05	0.05	0.05	0.05
CV (%)	-	-	-	25.46	41.87	-	-	5.06	22.55	29.73	22.56	22.80

NS = Non significant, LS= Level of significance, CV=Coefficient of variation, DAS=Days after sowing

pod^{-1}, 100-seed weight and harvest index over then control.

3.5 Length of the pod

The length of the pod was non-significantly influenced by different PGHs levels. Five studied growth hormones levels among them, the highest (1.98 mm) length of the pod was recorded from 30 ppm level of GA_3 hormone in Gibberellin group and the lowest (1.52 mm) was recorded from 50 ppm level of BAP hormone in Cytokinin group. Emongor (2007) reported that application ofGA_3at7 days after emergence at 30, 60 or 90 mg L^{-1} significantly increased cowpea pod length.

3.6 1000-grain weight

Significant effect was found in respect of 1000-grain weight of BARI chhola-9 due to different PGHs levels. The coefficient of variation was 5.06% identical that the variation was almost smellier. Among the growth hormones levels, GA_3 at 30 ppm GA_3 level was produced the highest (180.89g) weight of 1000-grain and lowest (171.40g) was derived from 10 ppm GA_3 level. Auxin group hormone, NAA produced the highest (168.74g) 1000-grain weight at 30 ppm NAA level and lowest (166.82g) at 10 ppm NAA level (Table 1). Other hormone in Auxin group, IAA shows the highest (168.68g) 1000-grain weight at 10 ppm IAA level and lowest (165.39g) at 30 ppm IAA level. For Cytokinin group hormone the highest weight of 1000-grain (1.64.78g) was recorded from 50 ppm KN level and lowest (160.35g) was recorded from 10 ppm KN level. For BAP the highest (158.63g) 1000-grain weight was recorded from 10 ppm BAP level and lowest (156.27g) was recorded from 50 ppm BAP level. The control level whereas no hormones doses are applied, shows the 1000-grain weight 160.53g. Giannakoula et al. (2012) reported that foliar application of auxins, gibberellins and cytokinins have increased the 1000 seed weight in lentil and the trend followed was (GA_3>IAA>KIN). Yadev & Bharud (2009) found that effect of 10 ppm of GA_3 and 20 ppm of NAA on Kabuli chickpea variety 'Virat' improved all yield components such as 1000-seed weight over then control.

3.7 Grain yield

The effect of different PGHs levels was significant for grain yield of BARI chhola-9. The coefficient of variation was 22.55%. GA_3 hormone with three levels in Gibberellin group gave the 1st performance on grain yield character. Among them, 30 ppm GA_3 level was derived the highest (2.68 t ha^{-1}) grain yield and lowest (2.62 t ha^{-1}) was derived from 10 ppm GA_3 level in between three GA_3 levels. Auxin group hormones- NAA produced 2nd highest grain yield. Among the three doses of NAA produced the highest (2.54 t ha^{-1}) grain yield at 30 ppm NAA level and lowest (2.50 t ha^{-1}) at 10 ppm NAA level (Table 1). Another hormone in Auxin group IAA, rank 3rd for grain yield parameter. The highest (2.41 t ha^{-1}) data derived from10 ppm IAA level and lowest (2.35 t ha^{-1}) derived from both 30 ppm and 50 ppm IAA level. KN hormone in Cytokinin group gave the 4th result among the five studied hormones on grain yield. The highest (2.22 t ha^{-1}) grain yield was recorded from 50 ppm KN level and lowest (2.00 t ha^{-1}) was recorded from 10 ppm KN level among three doses. BAP was the second studied hormone in Cytokinin group got last position for grain yield in case of five hormones. Although, the highest (1.95 t ha^{-1}) grain yield was recorded from 10 ppm BAP level and lowest (1.52 t ha^{-1}) was recorded from 50 ppm BAP level in case of BAP three doses. The control level whereas no hormones doses were applied shows the grain yield 1.97 t ha^{-1}. Stambera (1984) while working with celery concluded that GA_3 spray advanced growth and increased the yield. Thomas & Katterman (1986) who reported that foliar spray of GA_3 increased the height (16%) and yield (10%) of celery plants. Foliar application of 50 ppm GA_3 increased the seed yield and seed weight in grass pea (*Lathyrus sativus*) as reported by Rahman et al. (1989). Sharma & Singh (1999) recorded the highest seed yield of cowpea cv. Arka Garima was recorded from the foliar application of 40 ppm GA_3.

3.8 Stover yield

Stover yield was significantly influenced by different PGHs levels as we found from Table 1. The coefficient of variation was 29.73%. GA_3 hormone with three levels in Gibberellin group gave the 1stperformance in stover yield. Among them, 30 ppm GA_3 level was derived the highest (4.03 t ha^{-1}) stover yield and lowest (3.92 t ha^{-1}) was derived from 10 ppm GA_3 level in between three GA_3 levels. Auxin group hormones NAA produced 2nd highest stover yield. Among the three doses of NAA produced the highest (3.82 t ha^{-1}) stover yield at 30 ppm NAA level and lowest (3.75 t ha^{-1}) at 10 ppm NAA level. Another hormone in Auxin group IAA, rank 3rd for stover yield parameter. The highest (3.61 t ha^{-1}) data derived from10 ppm IAA level and lowest (3.53 t ha^{-1}) derived from 50 ppm IAA level (Table 1). KN hormone in Cytokinin group gave the 4th result among the five studied hormones on stover yield. The highest (3.43 t ha^{-1}) stover yield was recorded from 50 ppm KN level and lowest (3.01 t ha^{-1}) was recorded from 10 ppm KN level among three doses. BAP was the second studied hormone in Cytokinin group got last position for stover yield in case of five hormones. Although, the highest (2.93 t ha^{-1}) stover yield was recorded from 10 ppm BAP level and lowest (2.28 t ha^{-1}) was recorded from 50 ppm BAP level in case of NAA three doses. The control level whereas no hormones doses are applied, shows the stover yield 2.95 t ha^{-1}.

3.9 Biological yield

Biological yield of BAR chhola-9 was significantly influenced by different PGHs levels used. The coefficient of variation was 22.56%. GA_3 hormone with three levels in Gibberellin group gave the 1st performance in biological yield character. Among them, 30 ppm GA_3 level was derived

the highest (6.72 t ha^{-1}) biological yield and lowest (6.54 t ha^{-1}) was derived from 10 ppm GA_3 level in between three GA_3 levels (Table 1). Auxin group hormones- NAA produced 2nd highest biological yield. Among the three doses of NAA produced the highest (6.36 t ha^{-1}) biological yield at 30 ppm NAA level and lowest (6.26 t ha^{-1}) at 10 ppm NAA level. Auxin's group 2nd studied hormone IAA rank 3rd for biological yield. The highest (6.02 t ha^{-1}) data derived from10 ppm IAA level and lowest (5.88 t ha^{-1}) derived from 50 ppm IAA level. KN hormone in Cytokinin group gave the 4th result among the five studied hormones on biological yield. The highest (5.65 t ha^{-1}) biological yield was recorded from 50 ppm KN level and lowest (5.01 t ha^{-1}) was recorded from 10 ppm KN level among three doses. BAP was another studied hormone in Cytokinin group got last position for biological yield also in case of five hormones. Although, the highest (4.88 t ha^{-1}) biological yield was recorded from 10 ppm BAP level and lowest (3.79 t ha^{-1}) was recorded from 50 ppm BAP level in case of BAP three doses. The control level whereas no hormones doses are applied, shows the biological yield 4.92 t ha^{-1}.

3.10 Harvest index

The effect of different PGHs levels was significant in terms of harvest index of BARI chhola-9. The coefficient of variation was 22.80%. GA_3 hormone with three levels in Gibberellin group gave the 1st performance on harvest index (%). Among them, 30 ppm GA_3 level was derived the highest (40.4%) harvest index and lowest (38.25%) was derived from 10 ppm GA_3 level in between three GA_3 levels (Table 1). Auxin group hormones- NAA produced 2nd highest harvest index. Among the three doses of NAA produced the highest (37.25%) harvest index at 30 ppm NAA level and lowest (36.28%) at 10 ppm NAA level. Another hormone in Auxin group IAA, ranks 3rd for harvest index parameter. The highest (36.11%) data derived from 10 ppm IAA level and lowest (35.28%) derived from both 50 ppm IAA level. KN hormone in Cytokinin group gave the 4th result among the five studied hormones on harvest index. The highest (31.01%) harvest index was recorded from 50 ppm KN level and lowest (25.15%) was recorded from 10 ppm KN level among three doses. BAP was another studied hormone in Cytokinin group got last position for harvest index in case of five hormones. Although, the highest (23.96%) harvest index was recorded from 10 ppm BAP level and lowest (21.62%) was recorded from 50 ppm BAP level in case of BAP three doses. The control level whereas no hormones doses are applied, shows the harvest index 23.23% (Table 1). Jahan & Adam et al. (2013) investigated that, NAA (0, 25, 50, 75,100mg/l) effect onBARIGom-26non-significanthighestharvestindexwasalso recorded with 50 mg/l followed by 100 mg/l NAA application. Yadev & Bharud (2009) found that effect of 10 ppm of GA_3, 20 ppm of NAA on Kabuli chickpea variety 'Virat' improved all yield components such as harvest index over then control.

4. CONCLUSION

Yield properties of chickpea var. BARI Chhola-9 were found tobe enhanced by the foliar application of PGHs each with three doses in agro climate condition of major chickpea growing regions in Bangladesh. Study on yield and yield related characters, 30 ppm GA_3 level recorded the highest result in all the yield contributing parameters. Further studies could be conducted to clarify a very specific and crystal-clear conclusion.

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