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Research Article

Response of Kalmegh (*Andrographis peniculata* Burn F. Ex) To Foliar Spray of Plant Growth Hormones on Morpho-Physiological Traits

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ABSTRACT

Andrographis paniculata, commonly known as Kalmegh or green chirata, is used both in Ayurvedic and Unani system of medicines because of its immunological, antibacterial and hepatoprotective properties. It is an annual herb has high value compound used in the treatment of the various diseases. A field experiment was conducted at Farmer field Village, Badiyakhedi, District Sehore (Madhya Pradesh) during Kharif 2015 & 2016. Investigations undertaken aiming to increase the growth and yield traits of Kalmegh. Application of different plant growth hormones viz., Cycocel @100ppmm, Cycocel@150ppm, Cycocel@200ppm, GA_3 @100, GA_3@150ppm, GA_3@200ppm, NAA@100ppm, NAA@150ppm and water spray as control to study the influence of plant growth hormones on growth viz., plant height (cm) plant^{-1}, number of branches plant^{-1}, fresh weight of plant (g) dry weight of plant (g), leaf area cm^{2}plant^{-1}, chlorophyll index (SPAD), photosynthesis rate (µmol CO_2 m^{-2} s^{-1}), CO_2 (ppm) utilization and H_2O (Kpa) utilization at 90 DAT and yield viz., 1000-seed weight (g), seed yield (kg ha^{-1}), dry herbage yield (q ha^{-1}) and active ingredient content (Kg ha^{-1}) in Kalmegh at maturity. Application of different plant growth hormones significantly increased the maximum number of branches plant^{-1} under foliar sprayed with Cycocel @100ppm, maximum plant height^{-1}, fresh weight of plant, dry of plant, photosynthesis rate, CO_2 utilization (ppm) and H_2O utilization (Kpa) recorded under foliar spray with GA_3@100ppm, respectively.

Keywords: *GA_3, Cycocel, NAA spray, Photosynthesis rate, H_2O utilization.*

INTRODUCTION

About 90% of medicinal plants used by the industries are collected from the wild source. While over 800 species are used by industries, not more than 20 species of plant are under the commercial cultivation.

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Hence, more than 70% plant collection involved destructive harvesting because of the use of parts like root, bark, stem, wood and whole plant (in the case of herbs). This process is a definite threat to the genetic stock and diversity of medicinal plant resources, and ultimately to the economy of the country if the biodiversity is not sustainably used.

Kalmegh (*Andrographis paniculata* Burn F. Ex) is one of the important herbs among them. Kalmegh (*Andrographis paniculata* Burn F. Ex) belongs under large genus of herbs and shrubs in Acanthaceae family. Its origin is an India and Sri Lanka (Kirtikar & Basu, 1935). It is used in traditional medicine in China, India and Southeast Asia. It is known as "green chiretta" or "king of bitters"

King bitter is one among the prioritized medicinal plant and this is being used since long for the treating of fever, liver related diseases, jaundice, diabetes. Snake bites etc. The leaf and the whole herb contain the medicinal important. The fresh and dried leaves of Kalmegh are used as drugs in India. The leaves of Kalmegh contain maximum active principle andrographolides, homo-andrographolides, andrographesterol and andrographone. Andrographolides the major constituent in leaves which is bitter substance. The leaves contain much more of andrographolides then seed. The average Andrographolides content varied from 12.44 to 33.52 mg/g in dried leaves which is found maximum at 90-120 days. Whole part of the plant like leaves, stem and roots are used in different medicine.

In kalmegh major economic part of the plant is leaves. Growth regulators directly influence on the vegetative growth of the plant. Foliar application of the growth regulators directly enter plant and it help to increase the growth and yield of the kalmegh. So to know the potential of the plant hormones like Cycocel, GA_3 and NAA the present study was undertaken with the objective to maximize growth and yield of kalmegh. It also helped to find out the different concentration of the plant hormone which increases the yield. Further, study was taken for higher production at lower cost.

MATERIALS AND METHODS

This study was conducted at Farmer Field, Village Badiyakhedi, District Sehore, (Madhya Pradesh) during Kharif 2015 & 2016. There were nine treatments Cycocyl (100, 150 and 200 ppm), GA_3 (100, 150 and 200 ppm), NAA (100 and 150 ppm) and the water being the control. This study was done on the base of randomized complete block design. All the treatments were replicated three times in randomized block design. The seeds were sown on June 15th, 2015 and 2016 in nursery beds in lines of 10 cm apart and 1 cm deep and covered with fine sand. Seed germination was noticed after 7 days of sowing which continued till another week. A seed rate of 400 g per hectare was used. After sowing the seeds in the nursery, watering was applied daily by using rose can. Frequent weeding was done to keep the nursery free from weeds. The 30 days old seedlings were transplanted in the main field. The transplanting of seedlings, planting holes were made at 30×15 cm apart and one seedling was planted at each site. Seedlings were transplanted in the main field on July 15th, 2015 and July 16th 2016. The crop was raised as per recommended package of practices and the plant growth hormones were sprayed in three stages viz., 20, 40 and 60 DAT.

The data were recorded for morphological parameters viz. plant height, branches per plant were recorded at 30, 50, 70, 90 DAT and harvest, fresh weight of leaves per plant (g), dry weight of leaves per plant (g), fresh weight of plant (g), dry weight of plant (g), Chlorophyll index (SPAD), leaf area (cm^2 $plant^{-1}$) were recorded at 30, 50,70 and 90 DAT. Physiological parameter viz., Photosynthesis rate (µmol m^{-2} s^{-1}), stomatal conductance (mmol $m^{-2}s^{-1}$), transpiration rate (mmol $m^{-2}s^{-1}$), CO_2 utilization (ppm) and H_2O utilization (Kpa) at 30, 50, 70 and 90 DAT. yield parameter viz., number of seeds pod $^{-1}$, 1000-seed weight (g), pod weight (g $plant^{-1}$) seed yield (g $plant^{-1}$), seed yield (Kg ha^{-1}),

herbage yield (g plant^{-1}), herbage yield (Kg ha^{-1}), and dry herbage yield (Kg ha^{-1}), and biochemical parameters viz., andrographolide content (%) and active ingredient content (Kg ha^{-1}) of leaf at harvest. Finally mean data of the all characters were computed for statistical analysis as per standard procedure given by (Panse & Sukhtme 1989).

RESULTS AND DISCUSSION

Morphological traits

1. Plant height (cm) plant^{-1}

The present investigation revealed high significant variations existed among the impact of growth hormones on plant height plant^{-1} presented in (Table-1 and Fig.1).During 2015 and 2016 the maximum plant height plant^{-1} found was sprayed with GA_3 @100ppm (48.47 and 43.93) followed by GA_3 @150ppm (47.33 and 42.32) and NAA @100ppm (44.68 and 43.30), as compare to control (36.16 and 34.74) with mean value of (40.78 and 38.20). While it recorded the lowest value for Cycocel @200ppm (32.92 and 31.19) at 90 DAT. Whereas during the statistical analysis of variance of pooled data indicated that maximum plant height plant^{-1} at 90 DAT was attained by sprayed with GA_3@100ppm (46.20) followed by spray with GA_3 @150ppm (44.82) and NAA@100ppm (43.99) as compare to control (35.45) with mean value of (39.49) respectively. The increase of plant height due to stimulatory effect of GA_3 due to the biological activities of Gibberellic acid viz., stimulation of cell elongation and promotion of cell division, while, declined other treated plant of growth hormones. Similar findings were observed by studied the regulation of growth and yield in medicinal plant Geranium with spray of hormones, where in, height of the plant was much influenced by GA_3 and Alar sprays. (Mohandas & Sampath, 1985) and observed enhanced growth in the field at the concentration of GA_3 @ 100ppm showed an increase in plant height in Davana plants (Shedeed et al. (1990).

2. Number of branches plant^{-1}

Data presented in (Table-1 and Fig. 1) recorded at 90 DAT. During the year 2015 and 2016 indicated the significant impact of different growth hormones at different concentrations on number of branches plant^{-1}. During the year 2015 and 2016 the maximum number of branches plant^{-1} was exhibited sprayed with Cycocel @ 100ppm (34.88 and 32.00) followed by Cycocel @150ppm (31.22 and 30.11), GA_3 @100ppm (31.28 and 28.88) with mean of (28.93 and 26.15). While it recorded the lowest value for control (23.33 and 22.00) at 90 DAT. Whereas during the statistical analysis of variance of pooled data indicated that maximum number of branches plant^{-1} at 90 DAT was attained by sprayed with Cycocel@100ppm (33.44) followed by spray with Cycocel @150ppm (30.66) and GA_3 @100ppm (29.94) as compare to control (22.66) with mean of (27.54). While it recorded the lowest value for control (22.66) at 90 DAT. The increase of number of branches due to stimulatory impact of Cycocel viz., reduction in shoot elongation, can be related to enhanced physiological activities such as cell division, cell elongation, photosynthesis and translocation of nutrients, while, declined other treated plant of growth hormones. Whereas, significant differences were noted in respect of number of branches in plants applied with various growth regulators at different concentrations. In contrast to what was observed in crop increase number of branches as manifested in terms of shoots regenerated on the crop. The enhanced branching can be attributed to enhanced cell division and lateral growth due to Cycocel @ 100ppm and Cycocel @150ppm. The results are in conformity with those of (Verma & Sen, 2008) in coriander.

3. Dry weight of plant (g)

Data presented in (Table-1 and Fig. 1) recorded at 90 DAT. During the year 2015 and 2016 indicated the significant impact of different growth hormones at different concentrations on maximum dry weight (g) of plant. During 2015 and 2016 the maximum dry weight of plant was recorded sprayed

with GA_3 @ 100ppm (34.99 and 32.88) over the remaining growth hormones investigated by Cycocel @100ppm (32.59 and 30.48), Cycocel @150ppm (31.42 and 29.87) with mean value of (29.90 and 28.71). While it recorded the lowest value for control (25.88 and 25.77). Whereas during pooled analysis of variance the maximum dry weight of plant was found for GA_3 @100ppm (33.93) followed by Cycocel @100ppm (31.53) and Cycocel @ 150ppm (30.64) with mean of (29.31). However it recorded the lowest magnitude for control (25.82). The increase canopy structure of crop increases the chloroplast size and chlorophyll content in leaves, thus enhancing the photosynthesis process also transport of photosynthates source to sink, ultimately increase of dry weight of plant. The results are in accordance with the findings of Aftab et al. (2011) in *Artemisia annua* L.

Physiological traits

1. Photosynthesis rate (µmol m^{-2} s^{-1})

Data presented in (Table- 2 and Fig. 2) recorded at 90 days after transplanting. During the year 2015 and 2016 indicated the significant impact of different growth hormones at different concentrations on photosynthesis rate (µmol $m^{-2}s^{-1}$). During 2015 and 2016 the higher photosynthesis rate was recorded sprayed with GA_3 @ 100ppm (24.78 and 22.88) over the remaining growth hormones investigated by Cycocel @100ppm (24.21 and 22.24) and Cycocel @150ppm (23.40 and 22.06) with mean value of (22.75 and 21.07). While it recorded the lowest value for control (19.90 and 18.91). Whereas pooled analysis of variance the higher photosynthesis rate was found for GA_3 @100ppm (23.83) followed by Cycocel @100ppm 23.22) and Cycocel @ 150ppm (22.73) with mean of (21.91). However it recorded the lowest magnitude for control (19.40). The increase of photosynthesis rate due to stimulatory effect of GA_3 due to the increase of chlorophyll in leaf ultimately increase photosynthesis rate. (Kalpana et al., 2003) noticed that the photosynthesis rate increase at vegetative to reproductive stage and declined at pod development stage.

2. CO_2 utilization (ppm)

Data presented in (Table- 2 and Fig. 2) recorded at 90 DAT. During the year 2015 and 2016 indicated the significant impact of different growth hormones at different concentrations on CO_2 utilization (ppm) of plant. During 2015 and 2016 the higher CO_2 utilization of plant was recorded sprayed with GA_3 @ 100ppm (16.69 and 15.33) followed by Cycocel @100ppm (15.53 and 13.86) and GA_3 @150ppm (14.59 and 12.90) as compare to control (9.28 and 8.00) with mean value of (12.62 and 11.19). Whereas pooled analysis of variance the higher CO_2 utilization was found for GA_3 @100ppm (16.01) followed by Cycocel @100ppm (14.69) and GA_3 @ 150ppm (13.74) with mean of (11.90). However it recorded the lowest magnitude for control (8.63). The relationship between the daily net gross canopy CO_2 exchange rate and daily absorption of photosynthetic absorption rate were linear. Higher daily net and gross CO_2 exchange rate and phytomass value in the narrow space canopies were attributed to greater quantity of daily absorbed PAR through the season rates than difference in the efficiency of the various canopy structure (Wall & Kanemmasu, 2000).

2. H_2O utilization (Kpa)

Data presented in (Table- 2 and Fig. 2) recorded at 90 DAT. During the year 2015 and 2016 indicated the significant impact of different growth hormones at different concentrations on H_2O utilization (Kpa) of plant. The higher H_2O utilization of plant during 2015 and 2016 was recorded sprayed with GA_3 @ 100ppm (0.370 and 0.366) over the remaining growth hormones investigated by Cycocel @100ppm (0.362 and 0.358) and Cycocel @100ppm (0.362 and 0.358) with mean value of (0.341 and 0.338). While it recorded the lowest value for control (0.309 and 0.307). Whereas during pooled analysis of variance the higher H_2O utilization of plant was found for GA_3 @100ppm (0.368) followed by Cycocel @100ppm (0.360) and GA_3 @ 150ppm (0.350) with mean of (0.340). However it recorded the lowest magnitude for control (0.308). H_2O utilization is associated with enzymatic reaction required for every physiological mechanism; Low H_2O use may

be results retardation of electron process needed for production of ATP and $NADPH_2$ which are required for CO_2 reduction in dark reaction of photosynthesis.

Table 1: Impact of plant growth hormones on Plant height plant^{-1}, Number of branches plant^{-1} and Dry weight of plant (g) at 90 DAT in Kalmegh

Treatments	Plant height plant^{-1} At 90 DAT			Number of branches plant^{-1} At 90 DAT			Dry weight of plant (g) At 90 DAT		
	2015	2016	Pooled	2015	2016	Pooled	2015	2016	Pooled
Cycocel @100 ppm	35.99	33.30	34.64	34.88	32.00	33.44	32.59	30.48	31.53
Cycocel @150 ppm	35.68	33.42	34.55	31.22	30.11	30.66	31.42	29.87	30.64
Cycocel@ 200 ppm	32.92	31.19	32.05	26.88	21.00	23.94	26.41	25.97	26.19
GA_3 @100 ppm	48.47	43.93	46.20	31.00	28.88	29.94	34.99	32.88	33.93
GA_3 @150 ppm	47.33	42.32	44.82	29.22	25.00	27.11	30.49	28.86	29.67
GA_3 @200 ppm	44.63	41.83	43.23	28.11	24.33	26.22	29.05	28.11	28.58
NAA @100 ppm	44.68	43.30	43.99	27.66	27.11	27.38	28.54	27.08	27.81
NAA @150 ppm	41.20	39.78	40.49	28.11	25.00	26.55	29.81	29.38	29.59
Control	36.16	34.74	35.45	23.33	22.00	22.66	25.88	25.77	25.82
Mean	**40.78**	**38.20**	**39.49**	**28.93**	**26.15**	**27.54**	**29.90**	**28.71**	**29.31**
S.Em ±	**2.33**	**3.00**	**2.66**	**2.01**	**1.96**	**1.98**	**0.58**	**0.54**	**0.56**
CD at 5%	**7.18**	**8.98**	**8.08**	**6.04**	**5.88**	**5.96**	**1.77**	**1.62**	**1.69**

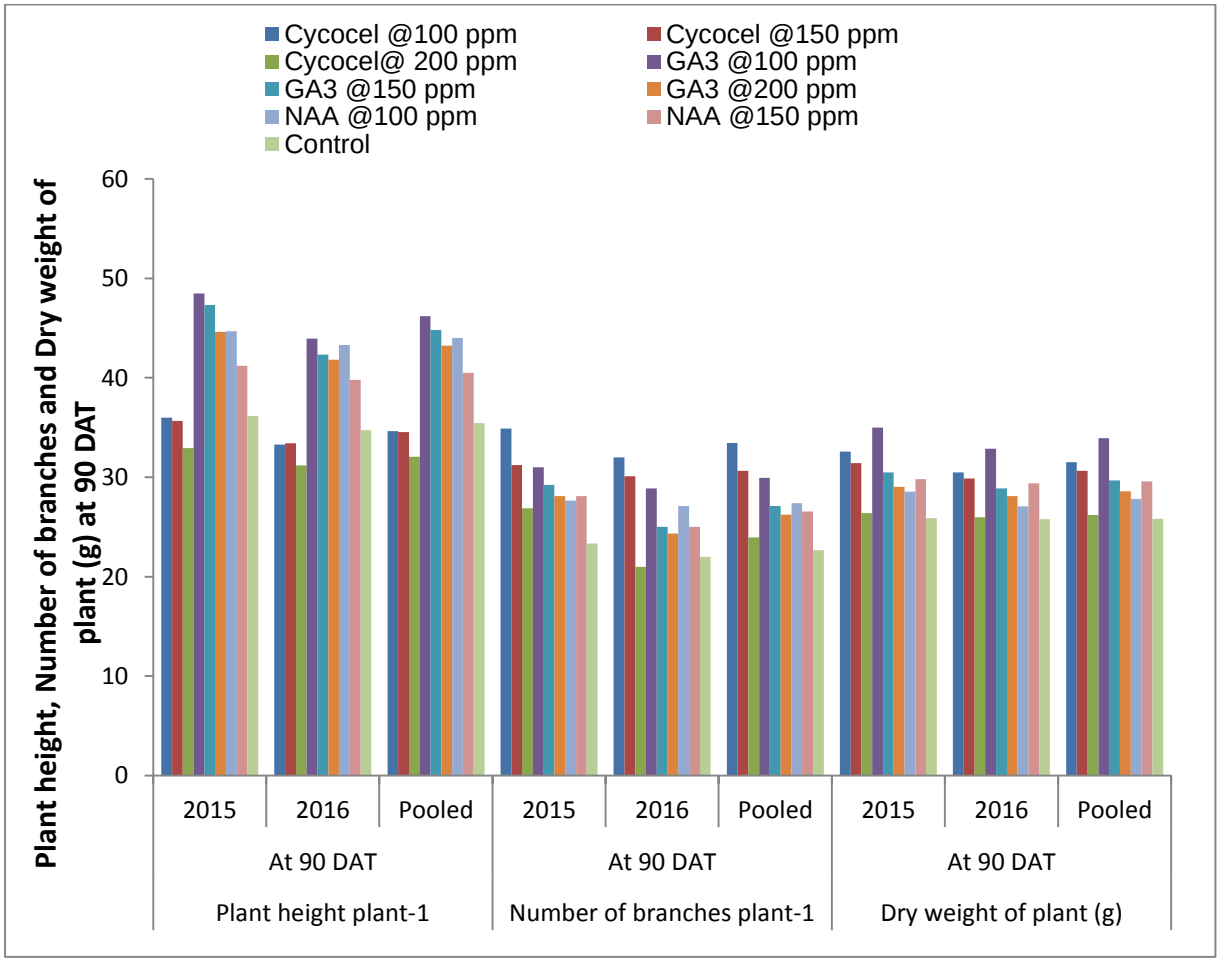

Fig. 1: Impact of plant growth hormones on Plant height plant^{-1}, Number of branches plant^{-1} and Dry weight of plant (g) at 90 DAT in Kalmegh

Table 2: Impact of plant growth hormones on photosynthesis rat (µmol m^{-2} s^{-1}), CO_2 utilization (ppm) and H_2O utilization (Kpa) at 90 DAT in Kalmegh

Treatments	Photosynthesis rate(µmol m^{-2} s^{-1}) at 90 DAT			CO_2 utilization (ppm) at 90 DAT			H_2O utilization (Kpa) at 90 DAT		
	2015	2016	Pooled	2015	2016	Pooled	2015	2016	Pooled
Cycocel @100 ppm	24.21	22.24	23.22	15.53	13.86	14.69	0.362	0.358	0.360
Cycocel @150 ppm	23.40	22.06	22.73	13.46	12.07	12.76	0.351	0.347	0.349
Cycocel@ 200 ppm	22.22	20.73	21.47	9.98	8.52	9.25	0.326	0.324	0.325
GA_3 @100 ppm	24.78	22.88	23.83	16.69	15.33	16.01	0.370	0.366	0.368
GA_3 @150 ppm	23.12	21.39	22.25	14.59	12.90	13.74	0.352	0.348	0.350
GA_3 @200 ppm	21.55	19.19	20.37	11.30	9.93	10.61	0.322	0.318	0.320
NAA @100 ppm	22.78	20.99	21.88	10.29	9.04	9.66	0.340	0.337	0.338
NAA @150 ppm	22.83	21.24	22.03	12.48	11.14	11.81	0.345	0.342	0.343
Control	19.90	18.91	19.40	9.26	8.00	8.63	0.309	0.307	0.308
Mean	**22.75**	**21.07**	**21.91**	**12.62**	**11.19**	**11.90**	**0.341**	**0.338**	**0.340**
S.Em ±	**0.38**	**0.79**	**0.58**	**0.77**	**0.41**	**0.59**	**0.03**	**0.01**	**0.02**
CD at 5%	**1.16**	**2.38**	**1.77**	**2.30**	**1.24**	**1.77**	**0.02**	**0.02**	**0.02**

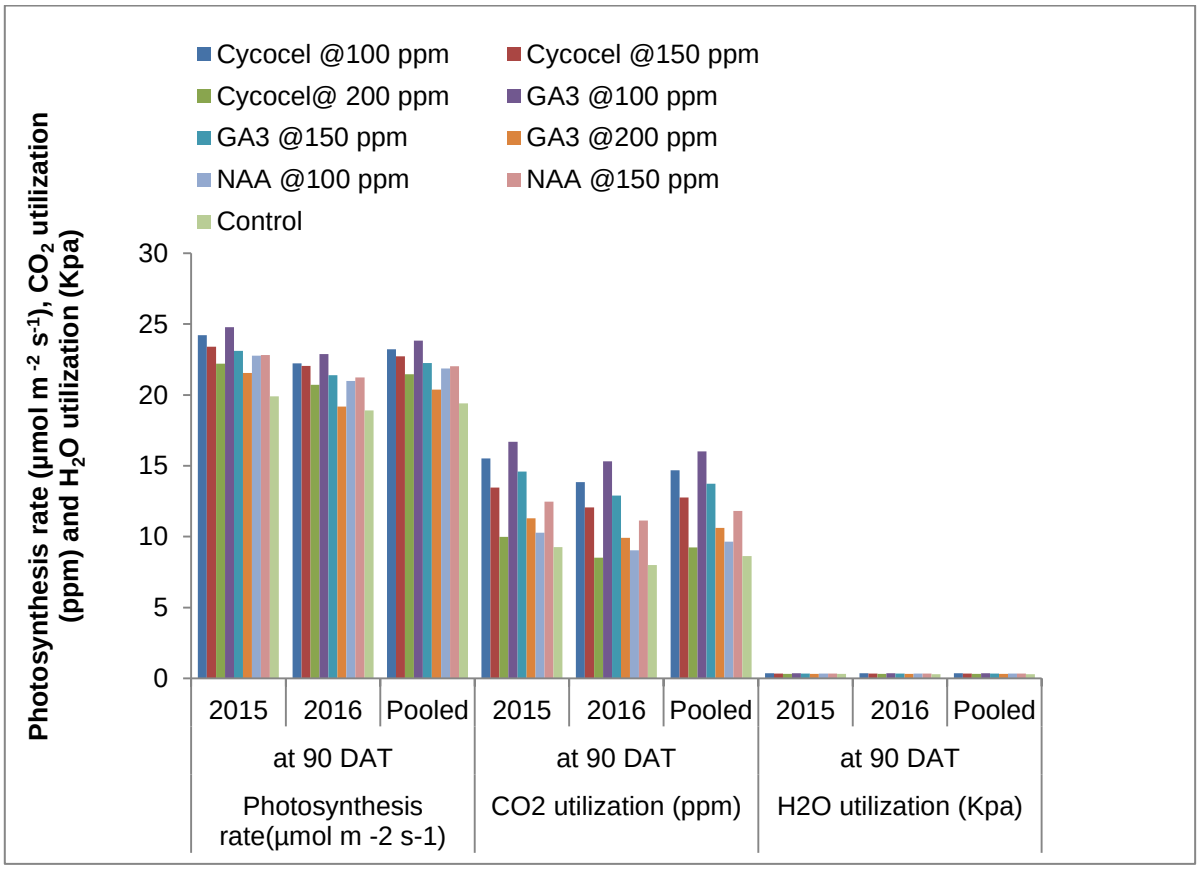

Fig. 2: Impact of plant growth hormones on photosynthesis rate (µmol m^{-2} s^{-1}), CO_2 utilization (ppm) and H_2O utilization (Kpa) at 90 DAT in Kalmegh

CONCLUSION

From the present investigation, it can be foliar spray of growth hormones on vegetative stages and reproductive stage after transplanting of plant viz., GA_3 @100ppm, GA_3 @150ppm and NAA @100ppm was most effective for realizing significantly maximum plant height, maximum number of branches plant^{-1} was noticed sprayed with Cycocel @ 100ppm followed by Cycocel @150ppm and GA_3 @100ppm, similarly maximum photosynthesis rate, CO_2 and H_2O utilization under spray with GA_3 @100ppm was significantly differed from other treatments to realize ultimately maximum profit correlated with dry herbage yield, active ingredient content and seed yield of kalmegh.

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