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Paclobutrazole, NAA and GA_3 Effects on Growth and Dry Matter Partitioning of *Andrographis paniculata* Nees.

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Abstract

Andrographis paniculata is an important medicinal plant which possesses many medicinal applications. Looking to the importance of plant growth regulators one study was carried out on the influence of foliar spraying treatments in the yield of Kariyatu. Different treatments which includes NAA (50,100 and 200 mg l^{-1}) , GA_3 (50,100 and 200 mg l^{-1}) and Paclobutrazol (50,100 and 200 mg l^{-1}) with one as control were considered as foliar application at 30 days after transplanting. Experimental results indicated leaf, shoot and total dry matter increased in all the treatments progressivelly upto harvest but root-shoot ratio decreased with increase crop growth stage that means high proportion of shoot is increases. Leaf area duration was increased progressively up to 75–105 days after transplanting and thereafter declined while crop growth rate was shown increased up to 45–75 days after transplanting then decreased during the 75–105 days after transplanting which means after reproductive stage to maturity phase of growth, crop growth rate decline. The biomass duration was increased with age of the crop till harvest. Significantly positive effect was reported in $GA_3$100 mg l^{-1} and lowest result was found in control. The translocation process must have been more prominent in the foliar spraying of GA_3 100 mg l^{-1} than rest of the treatments indicates that photosynthesis and translocation efficiency increases by foliar spraying treatments with growth regulators. GA_3 100 mg l^{-1} is efficient in dry matter production and its partitioning in leaves, stem as compared to other treatments.

Keywords: *Andrographis paniculata*, Paclobutrazole, growth,foliar spray, dry matter partitioning

1. Introduction

Andrographis paniculata (Burm.f.) Wall. ex Nees is an herbaceous plant in the family acanthaceae (Niranjan et al*.,* 2005) known as kariyatu or kalmegh. It's leaves contains several derivatives of diterpene lactones out of which andrographolide and neo-andrographolide are important one (Akowuah et al*.,* 2006). It is an erect, annual, 1–3 ft high herbal drug native to India and Sri Lanka.The Isle of France is the origin of kalmegh (Kurian and Sankar, 2007). *Andrographis paniculata* has andrographolide, a diterpenoid lactone (Tang et al., 1992) which is important in case of asthma(Bao et al., 2009), anti-inflammatory (Caceres et al.,1997). Anticancer (Shi et al., 2008) cold and fever (Deng, 1978)

Growth analysis uses different data in form of weight, areas, content of plant component by which interpreting plant form and function as well as physiological and evolutionary plant ecology (Hunt et al., 2002; Garnier et al., 1999).

Plant growth regulators play major role in regulation of many growth and behavioral processes (Rajendra and Jones Jonathan, 2009; Anjum et al., 2011). Plant growth regulators are being used for crop production worldwide (Lee, 2003). Auxin was identified as a plant growth hormone because of its ability to stimulate differential growth in response to gravity or light stimuli. (Yunde, 2010). Gibberellic acid (GA_3) promotes a number of desirable effects, including cell division, cell elongation, uniform flowering, photosynthesis etc. (Paleg, 1965). Foliar sprays of low concentration of GA_3 has promising results on performance and quality of various crops (Khan et al., 1998). GAs are used commercially to enhance morpho–physiological and yield characteristics of many crops (Lee, 2003). GA_3 treated plants show enhanced carbonic anhydrase activity (Khan,1996).This enzyme has a role in photosynthetic CO_2 fixation (Sultemeyer et al., 1993) as it takes part in the hydration of CO_2 and is strictly associated with chloroplast (Kachru et al., 1974). This may guarantee enough supply of CO_2 at the site of its fixation, thus determining the high net photosynthetic rate and consequently, high dry mass accumulation (Khan, 1996 and Khan, 1994). Biomass accumulation in GA_3 treated plants also improved by transport of photosynthates (Aloni et al., 1986) and Mulligan and Patrick (1979). Paclobutrazol is a plant growth retardant

reducing internodal growth to give stouter stems, darker green leaves and increases the leaf thickness. (Jaleel et al*.,* 2007). The growth regulating properties of paclobutrazol are mediated by changes in the levels of important plant hormones including the gibberellins, abscisic acid and cytokinins (Soumya et al., 2017).

It is estimated that more than 80% of the Worldwide population depends upon natural medicines for their healthcare (Choo et al., 2014). Most natural medicines are difficult to synthesize artificially or biologically, and they can only be obtained from medicinal plants. However, the growing need for plant-based medicines, health products, and pharmaceuticals, and the destructive exploitation of medicinal plants lead to increasing exhaustion of resources. This indicates that there is a strong demand for this herb. Cultivation of medicinal plants is an effective alternative way to solve this crisis. The importance of kariyatu and progressive farmers of Gujarat have come forward to cultivate this crop in their field. But, one of the most important problems in this crop is the low production of biomass, due to which the herbage yield is largely reduced, due to which economic loss occurs. To increase the biomass/ yield of kariyatu with foliar application of phytohormones will be helpful in achieving the goal of higher production and quality yield. Keeping this in view,an attempt was made to study the effect of Paclobutrazole, NAA and GA_3 on growth as well as dry matter portioning on kariyatu (*Andrographis paniculata* Nees) during *kharif* season.

2. Materials and Methods

An experiment was carried out at B. A. College of Agriculture, Department of Plant Physiology, Anand Agricultural University, Anand by transplanting during forghtnight of August to forghtnight of December, 2019.Experiment site was located at 22°35' North Latitude and 72°55' East Longitude and Altitude of 45 m above mean sea level. The area comes under semi-arid subtropical climate with hot summer and cool winter with an average rainfall of 866 mm. The crop was fertilized with the application of FYM @ 10 t ha^{-1} as per recommended dose of basal application prior to sowing. Arrangement of the treatments in randomized block design with three replications. Different treatments were T_1 (NAA 50 mg l^{-1}), T_2 (NAA 100 mg l^{-1}),T_3 (NAA 200 mg l^{-1}), T_4 (GA_3 50 mg l^{-1}), T_5 (GA_3 100 mg l^{-1}), T_6 (GA_3 200 mg l^{-1}), T_7 (paclobutrazol 50 mg l^{-1}), T_8 (paclobutrazol 100 mg l^{-1}), T_9 (paclobutrazol 200 mg l^{-1}) and T_{10} (control). The foliar application of the treatment was at 30 days after transplanting of kariyatu crop. The observations on growth and physiological parameters were recorded at different plant growth stages *viz*., 45, 75, 105 days after transplanting (DATP) and at harvest. Five plants from the net plot area of each treatment were selected randomly and tagged in each plot for recording growth parameters. Five plants from border lines were up rooted randomly for physiological parameters at different growth stages.

3. Result and Discussion

3.1. Effect on leaf dry weight (g plant^{-1}) at 45, 75, 105 DATP and at harvest

The results concerning leaf dry matter accumulation per plant is increased progressively up to harvest and its revealed that by different treatments shows significantly influenced. The results furnished in Table 3. At 45 DATP, significantly highest leaf dry weight g plant^{-1} (2.08 g) was recorded under treatment T5 (GA_3 100 mg l^{-1}) and it was statistically at par with treatments T_9 and T_8. The lowest leaf dry weight g per plant was recorded in control T_{10} (1.40 g). At 75 DATP, significantly highest leaf dry weight g plant^{-1} (10.40 gm) was recorded under treatment T_5 (GA_3 100 mg l^{-1}) and it was statistically at par with treatments T_8. The lowest leaf dry weight g per plant was recorded in control T_{10} (5.56 g). At 105 DATP, significantly highest leaf dry weight g plant^{-1} (17.65 g) was recorded under treatment T_5 (GA_3 100 mg l^{-1}). The lowest leaf dry weight g per plant was recorded in control T_{10} (10.16 g). At harvest, significantly highest leaf dry weight g per plant (21.52 g) was recorded under treatment T_5 (GA_3 100 mg l^{-1}). The lowest leaf dry weight g per plant was recorded in control T_{10} (10.20 g).

Over all experimental result showed that leaf dry weight g per plant during all periods was the highest in treatment T_5. The leaf dry weight g per plant were increased up 105 DATP and then stable or slightly increased up to harvest. Increase in dry weight of leaf was due to increase in number of branches per plant so directly increase number of leaves in plant was found higher in GA_3 treatment in all stages. Further paclobutrazol application has reduced plant height, increased no. of secondary branches per plant and leaf number which directly contributed to yield increase. This one is supported with the results of Anonymous (2016) in kalmegh.

3.2. Effect on shoot dry weight (g plant^{-1}) at 45, 75, 105 DATP and at harvest

Different phytohormones treatments has significant effect on shoot dry weight g per plant at 45, 75, 105 DATP and at harvest are indicated in Table 1. At 45 DATP, significantly highest shoot dry weight g per plant (1.11 g) was recorded under treatment T_5 (GA_3 100 mg l^{-1}) and it was statistically at par with treatments T_9, T_6 and T_8. The lowest shoot dry weight g per plant was recorded in control T_{10} (0.79 g).At 75 DATP, significantly highest shoot dry weight g per plant (18.24 g) was recorded under treatment T_5 (GA_3 100 mg l^{-1}) while lowest shoot dry weight g per plant was recorded in control T_{10} (11.80 g). At 105 DATP, significantly highest shoot dry weight g per plant (28.08 g) was recorded under treatment T_5 (GA_3 100 mg l^{-1}) and it was statistically at par with treatments T_8. The lowest shoot dry weight g per plant was recorded in control T_{10} (16.93 g).

At harvest, significantly highest shoot dry weight g per plant (31.10 g) was recorded under treatment T_5 (GA_3 100 mg l^{-1}) and it was statistically at par with treatments T_8 and T_9. The lowest shoot dry weight g plant^{-1} was recorded in control T_{10}

Table 1: Effect of Paclobutrazole, NAA and GA_3 on leaf and shoot dry weight during different growth stages

Treatments	Leaf dry weight (g plant^{-1})				Shoot dry weight (g plant^{-1})			
	45 DATP	75 DATP	105 DATP	At harvest	45 DATP	75 DATP	105 DATP	At harvest
T_1: NAA 50 mg l^{-1}	1.61	6.21	10.71	10.86	0.84	11.96	17.14	21.11
T_2: NAA 100 mg l^{-1}	1.75	7.77	12.35	13.92	0.93	14.37	22.45	26.10
T_3: NAA 200 mg l^{-1}	1.66	7.24	11.61	11.64	0.90	12.77	20.38	25.18
T_4: GA3 50 mg l^{-1}	1.65	7.13	11.59	11.87	0.89	12.51	18.60	20.89
T_5: GA_3 100 mg l^{-1}	2.08	10.40	17.65	21.52	1.11	18.24	28.08	31.10
T_6: GA_3 200 mg l^{-1}	1.77	7.87	13.61	15.41	1.02	14.00	22.94	26.61
T_7: Paclobutrazol 50 mg l^{-1}	1.74	7.71	12.59	13.02	0.93	13.74	21.56	26.02
T_8: Paclobutrazol 100 mg l^{-1}	1.99	10.27	15.37	19.12	0.99	15.95	26.08	28.76
T_9: Paclobutrazol 200 mg l^{-1}	2.07	8.0	14.85	16.04	1.06	16.04	23.68	28.51
T_{10}: Control (water spray)	1.40	5.56	10.16	10.20	0.79	11.80	16.93	20.43
SEm±	0.09	0.38	0.74	0.80	0.05	0.68	1.16	1.44
CD (*p*=0.05)	0.26	1.13	2.20	2.37	0.16	2.03	3.46	4.27
CV%	8.51	8.40	9.82	9.61	9.56	8.39	9.26	9.71

(20.43 g).Over all experimental result showed that shoot dry weight g per plant during all periods was highest in treatment T_5. The shoot dry weight g plant^{-1} were increased up 105 days after transplanting and then stable or slightly increased up to harvest. Increase in dry weight of shoot was due to increase in number of branches plant^{-1} which was higher in GA_3 treatment in all stages. Growth retardants paclobutrazol application has remove the apical bud dominance ref effect and height reduced and increased no. of secondary branches per plant so increased the shoot dry weight.

3.3. Effect on total dry matter (g plant^{-1}) at 45, 75, 105 DATP and at harvest

Total dry matter include stems, branches, leaf at various growth stages. Results indicates that phytohormones treatments has progressively increased and shows the significant effect of on total dry matter g per plant at 45, 75, 105 DATP and at harvest which presented in Table 2. At 45 DATP, significantly highest total dry matter g plant^{-1} (3.59 g) was recorded under treatment T_5 (GA_3 100 mg l^{-1}) and it was statistically at par with treatments T_9 and T_8. The lowest total dry matter g per plant

Table 2: Effect of phytohormones on total dry matter and root –shoot ratio during different growth stages

Treatments	Total dry matter (g plant^{-1})				Root-shoot ratio (weight basis)			
	45 DATP	75 DATP	105 DATP	At harvest	45 DATP	75 DATP	105 DATP	At harvest
T_1: NAA 50 mg l^{-1}	2.69	19.03	29.23	33.37	0.097	0.048	0.050	0.044
T_2: NAA 100 mg l^{-1}	2.94	23.24	36.65	41.88	0.095	0.050	0.053	0.047
T_3: NAA 200 mg l^{-1}	2.81	21.04	33.65	38.34	0.096	0.052	0.052	0.047
T_4: GA3 50 mg l^{-1}	2.78	20.60	31.58	36.23	0.097	0.049	0.047	0.042
T_5: GA_3 100 mg l^{-1}	3.59	29.84	47.81	54.82	0.126	0.042	0.046	0.042
T_6: GA_3 200 mg l^{-1}	3.06	22.90	38.12	43.64	0.099	0.047	0.043	0.039
T_7: Paclobutrazol 50 mg l^{-1}	2.92	22.41	35.62	40.51	0.095	0.045	0.043	0.038
T_8: Paclobutrazol 100 mg l^{-1}	3.34	27.36	43.31	49.82	0.118	0.043	0.045	0.040
T_9: Paclobutrazol 200 mg l^{-1}	3.45	25.16	40.43	46.43	0.103	0.046	0.049	0.042
T_{10}: Control (water spray)	2.42	18.03	28.11	31.83	0.101	0.039	0.038	0.043
SEm±	0.14	1.23	1.73	1.99	0.007	0.003	0.003	0.003
CD (*p*=0.05)	0.41	3.65	5.14	5.92	0.019	NS	NS	NS
CV%	7.94	9.26	8.22	8.28	10.93	9.52	11.28	12.44

was recorded in control T_{10} (2.42 g). At 75 DATP, significantly highest total dry matter g per plant (29.84 gm) was recorded under treatment T_5 (GA_3 100 mg l^{-1}) and it was statistically at par with treatments T_8. The lowest total dry matter g per plant was recorded in control T_{10} (18.03 g).At 105 DATP, significantly highest total dry matter g per plant (47.81 g) was recorded under treatment T_5 (GA_3 100 mg l^{-1}) and it was statistically at par with treatments T_8. The lowest total dry matter gm per plant was recorded in control T_{10} (28.11 g).

At harvest, significantly highest total dry matter g per plant (54.82 gm) was recorded under treatment T_5 (GA_3 100 mg l^{-1}) and it was statistically at par with treatments T_8. The lowest total dry matter gm per plant was recorded in control T_{10} (31.83 g). Total dry matter production is directly correlated with number of branching, number of leaf, LAI and finally with the yield. It is evident from the results that the plants treated with growth regulators especially GA_3 showed greater increase in dry matter production followed by paclobutrazol. The increase in dry matter production in GA_3 treatments can be attributed to the enhanced vegetative growth i.e., increased plant height, leaf number and leaf area.These above results with finding of Anonymous (2016) in kalmegh. Ram et al.,2022 also reported that GA_3 150 mg l^{-1} helps to enhance growth and alkaloid content in *Withania coagulance*(Stock) Dunal.

3.4. Effect on root-shoot ratio (dry weight basis) at 45, 75,105 DATP and at harvest

A perusal of data in Table 2 revealed that different phytohormones treatments showed their significant effect on root-shoot ratio (weight basis) at 45 days after transplanting while 75, 105 days after transplanting and at harvest root-shoot ratio (weight basis) was recorded non- significant. At 45 DATP, significantly highest (0.126) root-shoot ratio was recorded under treatment T_5 (GA_3 100 mg l^{-1}) and lowest(0.095) root-shoot ratio was recorded in treatment T_2 (NAA 100 mg l^{-1}). At 75, 105 days after transplanting and at harvest root-shoot ratio (weight basis) was recorded non- significant, however the lower root-shoot ratio was recorded in treatment T_5 (GA_3 100 mg l^{-1}) the root to shoot ratio is usually given as the ratio of the weight of the roots to the weight of the top of a plant. The better shoot growth attributed to lower root to shoot ratio. Most plants are able to adapt to changing conditions if the changes are not too drastic or rapid. According to Harris (1992), an increase in the root-shoot ratio would indicate that a plant was probably growing under less favorable conditions. Further he explain the top of the plant is pruned hence, relatively more carbohydrates are utilized to restore the top and less are available for the roots. In opposition, if roots are damaged or nutrients and water become limiting, relatively more carbohydrates go to roots and less to the top (Harris, 1992). Over all experimental result showed that root-shoot ratio during all periods was comparatively lower in treatment T_5. The root-shoot ratio is ratio between weights of the roots to the weight of the top of a plant it means increase shoot dry weight in our study root-shoot ratio decreased with increase crop growth stage that means high proportion of shoot is increase which obtain more light energy and accumulate photosynthesis. The root shoot ratio depends upon the partitioning of photosynthates which may influence by environment stimuli (Rogers et al.,1996).

3.5. Effect on leaf area duration (LAD) (days) at 45-75, 75- 105 and 105 DATP- at harvest

The results of leaf area duration was increased progressively up to 75–105 days after transplanting and thereafter declined in kalmegh. The effect of phytohormones of leaf area duration were affected by application of growth regulators during the growth period of kalmegh. The results of LAD during 45–75, 75-105 and 105 DATP- at harvest, were analyses and represent in Table 3.

During 45–75 days after transplanting time leaf area duration (10.35 day) was recorded maximum under treatment T_5 (GA_3 100 mg l^{-1}) and it was found statistically at par with treatments T_8 and T_6. Leaf area duration was recorded minimum in control T_{10} (7.16 day).

The leaf area duration increases as growth occurs in kalmegh. The significant highest leaf area duration (17.37 day) was obtained under treatment T_5 (GA_3 100 mg l^{-1}) due to the growth hormones further it was statistically at par with treatments T_8, T_9 and T_6 which are also due to the phytohormonal application The lowest Leaf area duration was found in control T_{10} (12.25 day) where no application of phytohormones, during 75-105 days after transplanting. The results represent leaf area duration at 105 DATP- at harvest effectively influence by the treatment and leaf area duration (9.64 day) was recorded maximum in treatment T_5 (GA_3 100 mg l^{-1}) which was statistically at par with treatments T_9 and T_8. Leaf area duration was recorded in control T_{10} (6.82 day) was lowest due to no application of phytohormones.

3.6. Effect on crop growth rate (CGR) (g m^{-2} day^{-1}) at 45-75,75-105 and 105 DATP - at harvest

The crop growth rate was shown increased up to 45–75 days after transplanting then decreased during the 75–105 days after transplanting i.e. after reproductive stage to maturity phase of growth, crop growth rate decline. The effect of phytohormones represent significant differences among the treatment at all growth phases. The crop growth rate between 45–75 DATP, 75–105 DATP and 105 DATP-at harvest is represented in Table 3. The data related to the crop growth rate between 45–75 days after transplanting was influenced by phytohormones treatment were analyzed and it was noted that foliar treatment application of GA_3 100 mg l^{-1} found higher (6.48 g $m^{-2}day^{-1}$) crop growth rate as compared to control (3.85 g m^{-2} day^{-1}) and it was at par with the application of foliar spray of paclobutrazol 100 mg l^{-1}

The variations for the crop growth rate due to the foliar spray of were significant at 75–105 DATP growth period.

Table 3: Effect of phytohormones on leaf area duration , crop growth rate and biomass duration during different growth stages

Treatments	Leaf area duration (LAD) (day)			Crop growth rate (CGR)			Biomass Duration (BMD)		
	45-75 DATP	75 -105 DATP	105 DATP- at harvest	(g^{-2} day^{-1})	75 -105 DATP	105 DATP- at harvest	(g day^{-1})	75 -105 DATP	105 DATP- at harvest
T_1: NAA 50 mg l^{-1}	7.37	12.63	7.02	4.03	2.52	2.05	325.74	723.85	469.52
T_2: NAA 100 mg l^{-1}	8.91	14.82	8.23	5.01	3.31	2.59	392.65	898.33	589.00
T_3: NAA 200 mg l^{-1}	8.18	13.72	7.62	4.50	3.11	2.42	357.75	820.42	539.96
T_4: GA3 50 mg l^{-1}	7.78	13.02	7.23	4.40	2.68	2.32	350.57	782.58	508.55
T_5: GA_3 100 mg l^{-1}	10.35	17.37	9.64	6.48	4.44	3.47	501.46	1164.82	769.74
T_6: GA_3 200 mg l^{-1}	9.45	15.73	8.58	4.90	3.76	2.73	389.42	915.21	613.15
T_7: Paclobutrazol 50 mg l^{-1}	8.28	13.88	7.72	4.81	3.26	2.43	379.92	870.40	570.93
T_8: Paclobutrazol 100 mg l^{-1}	9.85	16.44	9.16	5.93	3.94	3.21	460.37	1059.99	698.45
T_9: Paclobutrazol 200 mg l^{-1}	9.20	16.22	9.31	5.36	3.77	2.95	429.11	983.82	651.50
T_{10}: Control (water spray)	7.16	12.25	16.82	3.85	2.49	1.84	306.65	691.99	449.50
SEm±	0.37	0.75	0.31	0.31	0.25	0.15	32.63	32.63	23.03
CD (*p*=0.05)	1.09	1.94	0.91	0.93	0.75	0.46	53.64	96.96	68.43
CV%	7.37	7.73	6.52	10.96	13.16	10.23	8.03	6.34	6.81

The highest crop growth rate (4.44 g m^{-2} day^{-1}) was recorded under treatment GA_3 100 mg l^{-1} and remain at par with foliar application of paclobutrazol 100 mg l^{-1} and Paclobutrazol 200 mg l^{-1} as compared to control (2.49 g m^2 day^{-1}) during 75–105 DATP. The crop growth rate drastically reduced towards harvesting stage in kalmegh even though there was significant difference were recorded between 105 DATP-atharvest period because of the phytohormones applications GA_3 100 mg l^{-1} spray at 30 day after transplants showed maximum crop growth rate (3.47 g m^{-2} day^{-1}) and it was statistically at par with application of paclobutrazol @100 mg L^{-1}as compared to the control i.e. no foliar spray of phytohormones.

Crop growth rate (CGR) is used as a character for estimating production efficiency of crop stand, which is influenced by LAI, photosynthetic rate and leaf angle and is an index of amount of light interception. CGR was recorded the highest in T5 at 45-75 DATP due to more sun shine hours available for photosynthetic activity and temperature recorded the highest in standard week 41th to 42nd. Crop growth increased at pick period 75 DATP there after crop growth was shown steady due to transport of photosynthate towards the reproductive phase. In onformity with results of Patil and Patil (2013) reported growth regulators significantly increased crop growth rate through stimulates physiological process

3.7. Effect on biomass duration (g day^{-1}) at 45–75, 75–105 and 105 DATP - at harvest

The result indicates that biomass duration was increased towards the maturity in kalmegh. The results shows that the biomass duration was increased significantly at different growth phases biomass duration (BMD) was higher may be due to the application of the growth regulators as a foliar spray in kalmegh

The data represent in Table 3. between 45–75 days after transplanting, 75- 105 days after transplanting and 105 DATP-at harvest by different phytohormones foliar spray to shows the effect on biomass duration in kalmegh. The result indicated that the treatment GA_3 100 mg l^{-1} found maximum (501.46 g day^{-1}) biomass duration which was statistically at par with the foliar spray treatment of paclobutrazol 100 mg l^{-1}. The minimum biomass duration was recorded in control treatment (306.65 g day^{-1}) during the 45–75 days after transplanting of kalmegh. When GA_3 100 mg l^{-1} foliar spray significantly higher (1164.82 g day^{-1}) biomass duration during 75–105 days after transplanting. The results in control (691.99 g day^{-1}) recorded minimum biomass duration during 75–105 days after transplanting. When biomass duration was recorded during 105 DATP- to harvest period significantly maximum biomass duration (769.74 g day^{-1}) was noted in case of GA_3 100 mg L^{-1}foliar spray was given while the lowest biomass duration was recorded (449.50 g day^{-1}) in case of no foliar spray of phytohormones. The data presented inTable 3,during 105 DATP- at harvest were only 15 days of the duration so the data reflect lower value than the previous but actually it higher biomass at the maturity.

The biomass duration was increased with age of the crop till harvest. The biomass duration was increased because of application of growth regulators/phytohormones which may be attributed increased dry matter production/herbage yield.

The present study revealed biomass duration is increased from 45 days after transplanting to 105 days after transplanting it might be due to increase in growth rate,photosynthesis and redistribution of dry matter to vegetative and reproductive plant part.

4. Conclusion

Foliar spraying of GA_3 100 mg l^{-1} at 30 days after transplanting were effective in influencing on growth and dry matter partitioning in respect of morpho-physiological growth parameters and identified superior for production potential which was at par with paclobutrazole 100 mg l^{-1} treatment. The increase in dry biomass of *Andrographis paniculata* might be due to the improvement in the metabolites due to phytohormone treatments and help to increase transport of assimilates from source to sink and finally conversion into yield.

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