Physiological Effect Of Auxins On Growth Characteristics And Productive Potential Of *Verbascum thapsus* – A Medicinal Plant.

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ABSTRACT

Due to current revival of interest in herbal drugs and pharmaceuticals, demand for medicinal plants is increasing day by day leading to destructive harvesting which ultimately has resulted into reduction and even extinction of many rare medicinal plants. Plant growth regulators like auxins have proved to increase the productivity and growth characteristics of many plants. They have proved their importance in agro technology of many plants hence, in the present study, an effort has been made to suggest agro technology of a very important medicinal plants-*Verbascum thapsus* (family: Scrophulariaceae), a hairy biennial plant which grows as wild in Himalayan region. The plant is used for curing a wide range of chest complaints and also to treat diarrhea. The leaves and flowers are Anodyne; Antiseptic; Astringent; Demulcent; Emollient; Expectorant; Narcotic; Odontalgic; Vulnerary.

Effect of foliar spray of different concentration of auxins (IAA (50,100,200 ppm), 2,4-D (5,10,20 ppm) on augmentation of growth characteristics was studied. Observations reveal that IAA 50 ppm increased the shoot and root length, number of branches, nodes and leaves, while IAA 200 ppm was found to be the best for leaf area, number of flower and fruits. 2,4-D treated plants exhibited much reduction in number of flowers, indicating the adverse effect of this chemical towards growth. IAA 50 ppm resulted in maximum productivity of aboveground and underground compartment of *V. thapsus* on annual basis.

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Keywords *Verbascum thapsus,* growth regulators, Net Primary Production, Relative Growth Rate, Net Assimilation Rate.

INTRODUCTION

Extensive research work on different ecological and physiological aspects of medicinal plants has been done in India and abroad. Studies pertaining to the agro technology of most of the important medicinal plants are fragmentary. Due to lack of agro technology the cultivation of medicinal plants is rather uncommon in the rural sector. But the commercial production of these plants is being largely felt due to increasing demand for herbal based medicines. Growth regulators like auxins have been reported to affect the growth behaviour and productivity of plants. *Verbascum thapsus* (Great or common mullein) is native to Europe, Northern Africa and Asia. It is widely used for herbal remedies with emollient and astringent properties. It is especially recommended for coughs and related problems. It acts by reducing the formation of mucus and stimulating the coughing up of phlegm, and is a specific treatment for tracheitis and bronchitis, but also used in topical applications against a variety of skin problems. A decoction of the seeds is used to soothe chilblains and chapped skin. A homeopathic remedy is made from the fresh leaves. It is used in the treatment of long-standing headaches accompanied with oppression of the ear. The plant is also used to make dyes and torches.

The leaves and flowers of the plant are anodyne, anti-inflammatory, antiseptic, antispasmodic, astringent, demulcent, diuretic, emollient, expectorant and vulnerary. An infusion is taken internally in the treatment of a wide range of chest complaints and also to treat diarrhea. The plant is harvested when in flower and is dried for later use. The decoction of the roots is said to alleviate toothache and also relieve cramps and convulsions. The seeds are slightly narcotic and also contain saponins. Considering the importance of this plant, the agro technology of this plant is being reported in the present paper.

MATERIALS AND METHODS

The present study was undertaken to evaluate the effect of foliar spray of varying concentrations of growth regulators (IAA and 2,4-D) on *V. thapsus* to workout the quantitative characters and emphasis was laid down on Growth pattern study, Biomass structure and Net Primary Production.

The experiment was laid out in seven plots of 10 x 5 m size during April to September 2002 at Pauri town (1650 m AMSL) situated on Western Himalayas. The seeds of *V. thapsus* germinated after 20 days and were transplanted to different experimental plots after 30 days of germination.

The plants were subjected to foliar spray with auxins such as IAA (200, 100 and 50 ppm), 2,4-D (20, 10 and 5 ppm) and control (water spray) after the measurement of initial shoot length. Foliar spray was conducted at 60, 90 and 120 day stage. Final observations were made at 150 day stage.

RESULTS

Shoot length at 150 day stage reflected higher value in IAA 50 ppm treated plants (143.50 ± 12.65) over control treated plants (122.00 ± 0.78) whereas 2,4-D treated plants exhibited lower shoot length (104.00 ± 12.00) than control. Shoot diameter was maximum in plants of control plot (18.30 ± 1.85) followed by IAA 50 ppm (15.96 ± 1.35) and 2,4-D 5 ppm (15.86 ± 1.20) treated plants.

All concentrations of IAA also responded favourably towards root length as compared to control (17.00 ± 1.60). IAA 50 ppm treated plants exhibited longest roots (20.00 ± 2.10 followed by 100 ppm (19.25 ± 1.65). higher concentration of 2,4-D (20 ppm) had lower value of root length (14.25 ± 1.60) as compared to control.

In IAA and 2,4-D treated plants shoot and root length and number of leaves increased with the decrease in concentration of chemicals Root diameter was maximum in control (20.81±1.34) followed by 2,4-D 5 ppm (18.90±1.26) and IAA 50 ppm treated plants (18.75±1.85), while leaf areas was maximum in IAA 200 ppm (311.75 ± 13.75) and 50 ppm (308.00 ± 13.05). Control treated plants had higher value of leaf area than all 2,4-D treated plants.

Value of node number was highest in IAA 50 ppm (20.50±2.55), plants of control plot followed next (19.50±1.80). 2,4-D treated plants had lower number of nodes compared to other treatments (Table 2).

Number of flowers at 120 day stage was higher in IAA treated plants over control. 2,4-D treated plants reflected lower number of flowers indicating the adverse effect of this chemical substantially.

At the end of the study period, the number of fruits was higher in IAA 200 ppm (313.00 ± 18.08). Control plot had 217.00 ± 12.10 numbers of fruits at this stage.

Gradual increment of biomass of aboveground and underground compartment has been observed in different treatments. Maximum biomass on dry weight basis was in IAA 50 ppm in both compartments followed by other IAA treated plants in aboveground and 2,4-D 5 and 10 ppm treatments in underground compartment. . Minimum biomass as usual was in 2,4-D 20 ppm treated plants (Table 5).

Maximum aboveground productivity on yearly basis was observed in IAA 50 ppm (followed by IAA 200 and IAA 100 ppm. Plants of control exhibited lower Net Primary Productivity (NPP) than IAA treated plants. 2,4-D 20, 10 and 5 ppm plants had lower total productivity than control. In 2,4-D treated plants, NPP of underground compartment was highest in 5 ppm plants and lowest in 20 ppm treatment of 2,4-D. control had higher values than IAA 200 and 2,4-D 20 ppm treated plants.

Thus IAA 50 ppm increased the shoot and root length, number of nodes and leaves, whereas IAA 200 ppm was found to best for leaf area and number of flowers and fruits.

Rate of Extension Growth (REG)

REG values ranged from 0.45 to 0.48 at 60 day stage. Increasing trend was noticed at 90 and 120 day stage in all treatments. At 150 day stage REG also increased in all treatments except 2,4-D 5 ppm (4.49) treated plants (Table 3).

Leaf Area Expansion Rate (LAER)

Leaf area expansion rate initially ranged from 0.08 to 0.79. Increasing trend was noticed at 90 and 120 day stage. In IAA treatment an increased trend was observed while in control and 2,4-D treated plants a decreasing trend was noticed at 150 day stage. Maximum LAER value was reflected in IAA 200 ppm (5.55) while minimum value was recorded in 2,4-D 20 ppm (5.33) treatments at the end of the study period.

Relative Growth Rate (RGR), Net Assimilation Rate (NAR) and Leaf Area Ratio (LAR)

RGR reflected increasing trend upto 120 day stage followed by a decline at 150 day stage. NAR on the other hand shown increasing trend during the entire study period. 6 to 15 times increment in NAR was noticed in between 90 to 120 day stage while this increment was 2 to 3 times during 120 to 150 day stage.

LAR exhibited fluctuating trend in different treatments. Values decreased at 120 day stage in all the treatments except 2,4-D 10 and 20 ppm treated plants (Table 4).

DISCUSSIONS

Report of different workers revealed that application of growth regulators ultimately affect the endogenous level of auxin which finally work on the growth and development of the plants. Literature review revealed that the time of application with respect to growth stage of plant (Kamp and Nightingle, 1999) with the concentration of chemical play an important role on growth modification and yield. Indole-3-acetic acid (IAA) as the principal auxin in higher plants, stimulate fundamental processes such as cell elongation and division (Kende and Zeevaart, 1997).

Role of growth regulators in improving branching and enhancing different growth processes of many ornamental crops has been extensively studied. Growth augmentation and yield due to foliar spray of IAA has been reported by several workers (Sinha and Pal, 1983; Patil *et al*., 1987; Fuloria *et al.,* 1990; Arora *et al*., 2000). IAA concentration upto 100 ppm has been found to increase shoot length in *Hippeastrum hybridium* (Bose *et al*., 1980). IAA sprayed plants of *V.thapsus* reflected positive response towards maximum leaf number, leaf area, number of flowers and fruits than the other treatments in this study (Table 1). Increased leaf area (length and breadth) and number of leaves per plant by IAA treatment observed in the present study is in agreement with those of Das *et al*. (1992), Mishra *et al*. (2000) and Nandhini Devi and Chezliyas (2001). Increased leaf area means higher photosynthesis efficiency of the plants treated with IAA. Accumulation of higher photosynthates has a direct bearing on net productivity of the plant. Accumulation and its partitioning to different compartments at various stages of life cycle may be attributed to varying values of NAR of above and underground compartment in all the plants in the present study.

Root length was maximum in IAA 50 ppm similar are the findings of Parekh (1968) who observed root improvement in tomato by using IAA. Similar results have been observed in *Dendrocalamus stictus* by Misra and Misra (1982). Increasing trend in the growth was observed with decreasing concentration of 2,4-D.

Rate of Extension Growth (REG) and Leaf Area Expansion Rate (LAER) was maximum in all the three concentrations of IAA (Table 3). IAA also influenced Relative Growth Rate (RGR) and Net Assimilation Rate (NAR) reflecting maximum values, whereas Leaf Area Ratio (LAR) was maximum in 2,4-D 20 ppm treatment (Table 4).

Kumar (1982) using 10 and 50 ppm concentrations of 2,4-D on groundnut concluded that lower concentration is more effective to increase dry weight. Similar result in the present study was obtained with *V. thapsus* plants treated with 2,4-D 10 and 5 ppm exhibiting higher UG biomass on dry weight basis than control (Table 5). Dry weight of aboveground compartment was maximum in IAA 200 ppm (31.03 ± 2.88) whereas minimum DW was observed in 2,4-D 20 ppm (7.80 ± 0.66). IAA 50 ppm exhibited maximum DW values (9.11 ± 1.05) of Underground compartment in the present study (Table 5). Fuloria (1990) has reported higher productivity with lower concentrations of growth retardent in oat and ragi crops. Responses observed in the present study are in conformity with these finding. Moisture percentage was maximum in control treated plants in the aboveground compartment. IAA 50 ppm treated plants reflected higher moisture percentage in the underground compartments in the present study.

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Table 1 : Effect of growth regulators on the growth behaviour of *V.thapsus*.

Treatment	**Shoot length**	**Shoot diameter**	**Root length**	**Root diameter**
IAA 200 ppm	133.50± 12.50	15.56±1.35	17.75±1.25	17.24 ± 1.24
IAA 100 ppm	135.00 ± 12.00	15.85 ± 1.90	19.25 ± 1.65	17.65 ± 1.25
IAA 50 ppm	143.50 ± 12.65	15.96 ± 1.35	20.00 ± 2.10	18.75 ± 1.85
2,4-D 20 ppm	52.00 ± 5.00	12.80 ± 1.50	14.25 ±1.60	15.80 ±1.25
2,4-D 10 ppm	76.00 ± 7.20	14.18 ± 1.25	18.79 ± 1.80	17.90 ± 1.24
2,4-D5 ppm	104.00 ± 12.00	15.86 ± 1.20	19.00 ± 1.90	18.90 ± 1.26
Control	122.00 ± 12.00	18.30 ± 1.85	17.00 ± 1.60	20.61 ± 1.34

Table 2 : Effect of growth regulators on the growth behaviour of *V.thapsus*

Treatment	**Number of nodes**	**Number of leaves**	**Leaf area**	**Number of flowers**	**Number of fruits**
IAA 200 ppm	17.50 ± 1.57	17.00 ± 1.85	311.75 ±13.75	29.50 ± 2.56	313.00 ±18.08
IAA 100 ppm	15.50 ± 1.59	17.50 ± 1.67	310.00 ± 13.00	27.50 ± 2.65	269.00 ± 12.60
IAA 50 ppm	20.50 ± 2.55	22.50 ± 2.50	308.00 ± 13.05	27.00 ± 2.60	192.00 ± 16.00
2,4-D 20 ppm	11.00 ± 1.08	13.50 ± 1.53	249.25 ± 12.75	4.90 ± 1.06	18.50 ± 1.80
2,4-D 10 ppm	13.50 ± 1.50	14.50 ± 1.45	251.25 ± 17.75	5.50 ± 1.08	-
2,4-D 5 ppm	15.00 ± 1.65	16.00 ± 1.62	257.75 ± 14.10	12.50 ± 1.26	44.00 ± 4.02
Control	19.50 ± 1.80	22.50 ± 2.15	262.25 ± 19.25	26.00 ± 2.05	217.00 ± 12.10

Table 3 : Rate of Extension Growth (REG) and Leaf Area Expansion Rate (LAER)

Treatment	No. of days REG	LAER	REG	LAER	REG	LAER	REG	LAER
	60		90		120		150	
IAA 200 ppm	0.45	0.09	3.005	4.99	4.712	5.53	4.734	5.55
IAA 100 ppm	0.48	0.09	2.996	4.94	4.719	5.52	4.744	5.55
IAA 50 ppm	0.48	0.10	2.828	4.60	4.760	5.53	4.804	5.54
2,4-D 20 ppm	0.53	0.09	2.750	4.16	3.746	5.37	3.823	5.33
2,4-D 10 ppm	0.48	0.09	2.869	4.29	4.005	5.38	4.194	5.34
2,4-D 5 ppm	0.47	0.08	2.897	4.39	4.522	5.39	4.490	5.37
Control	0.47	0.79	3.131	4.43	4.35	5.41	4.655	5.38

Table 4 : Relative Growth Rate (RGR), Net Assimilation Rate (NAR) and Leaf Area Ratio (LAR) in *V.thapsus*.

Treatment	60*			90*			120*			150*		
	RGR	NAR	LAR	RGR	NAR	LAR	RGR	NAR	LAR	RGR	NAR	LAR
IAA200 ppm	0.22	0.40	0.05	3.21	5.70	9.43	3.38	89.05	7.86	3.32	168.05	9.57
IAA100 ppm	0.23	0.49	0.05	2.38	9.00	16.08	3.42	84.36	10.90	3.29	166.79	9.53
IAA 50 ppm	0.23	0.47	0.05	2.29	9.23	14.16	3.59	59.28	8.86	3.37	165.78	8.40
2,4-D20 ppm	0.23	0.63	0.04	1.92	5.27	11.46	2.15	37.55	17.78	1.98	136.09	29.46
2,4-D10 ppm	0.23	0.53	0.04	2.17	6.89	11.70	2.52	43.24	13.79	2.51	137.40	18.78
2,4-D 5 ppm	0.22	0.60	0.04	2.28	3.66	10.12	3.11	46.35	9.90	2.99	140.50	11.14
Control	0.23	0.62	0.04	2.31	3.87	9.47	3.26	47.63	8.83	3.29	141.82	7.98

***values taken in mg for calculation to avoid –ve value. Values of NAR are taken at 10^{-1} level**

Table 5 : Periodic variation in the aboveground (AG), underground (UG) and moisture percentage in *V.thapsus*.

Treatment		**Aboveground**	**Underground**		**Moisture %**
	FW	182.50 ± 12.55	20.25 ± 1.90	**AG**	488
IAA 200 ppm	**DW**	31.03 ± 2.88	6.28 ± 0.58	**UG**	222
IAA100 ppm	**FW**	190.00 ± 10.80	24.40 ± 2.10	**AG**	525
	DW	30.40 ± 2.50	7.56 ± 0.88	**UG**	223
IAA 50 ppm	**FW**	219.00 ± 19.05	30.36 ± 3.10	**AG**	566
	DW	32.85 ± 3.10	9.11 ± 1.05	**UG**	233
2,4-D20 ppm	**FW**	52.00 ± 5.02	18.95 ± 1.40	**AG**	566
	DW	7.80 ± 0.66	6.25 ± 0.72	**UG**	203
2,4-D10 ppm	**FW**	89.00 ± 7.50	27.02 ± 1.90	**AG**	566
	DW	13.35 ± 1.25	8.92 ± 0.70	**UG**	202
2,4-D 5 ppm	**FW**	110.00 ± 10.80	28.00 ± 0.62	**AG**	400
	DW	22.00 ± 1.65	8.92 ± 0.62	**UG**	212
Control	**FW**	215.00 ± 17.50	25.40 ± 2.15	**AG**	614
	DW	28.09 ± 2.80	8.13 ± 0.80	**UG**	213

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