

Enhancement in Growth and Yield of Ashwagandha (*Withania Somnifera* (L.) Dunal) by Counteracting Effect of Infrared Supplemented with Ultraviolet-B Radiation

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Abstract: Ashwagandha (*Withania somnifera*(L.) Dunal), member of family Solanaceae, is one of the most important medicinal plants required in allopathic, ayurvedic and unani system of medicines. The roots of ashwagandha possess health maintenance and restoration properties, similar to ginseng roots, hence known as Indian ginseng. The leaf is useful for inflammation, swelling and conjunctivitis. Bark decoction helps in asthma. Its extract has powerful protective effects on nervous system. Therefore ashwagandha is demanding in pharmaceutical market, so production is less than its consumption, therefore included in critically endangered species in Red Data book. Ozone depletion resulted in increased UV-B radiation, have desruptive effects on growth and development of flora but for short period at regular intervals it is beneficial, and IR radiation enhance the yield in plants. Since the plant growth is dynamic complex process and the solar radiation at different altitudes alter the growth, development and biosynthesis in plants. So looking at the view of high demand and sustainable use of natural wealth. Ashwagandha has much scope for wide cultivation. Since information on these aspects of ashwagandha is meagre. Therefore in present investigation counteracting effects of infrared and UV-B radiation on ashwagandha was undertaken to evaluate growth and yield of crop.

Keywords: IR, UV-B, growth, yield

1. Introduction

Stratospheric ozone layer depletion is one of the most important component of global climate change and results in global warming. UV-B radiation, a part of the sunlight, has wavelength ranges from 280-320 nm and infrared (IR) radiation lies in 680-700nm light spectrum. Ozone depletion has prompted recent efforts in assessing the potential damage to vegetation due to enhanced levels of ultraviolet-B radiation (World Meteorological Organization,1989; Grant,1990; Bornman,1991; Nunez *et. al.*,1994; Caldwell *et. al.*,1998; Mandronich *et. al.*,1998). UV-B irradiance have direct as well as indirect impact on plants, as damages detected in many cell components including membranes, proteins DNA, inconjunction with alteration on plant growth, morphology, physiological and biochemical processes (Jansen *et. al.*,1998). Plant species and varieties differ greatly in their response, with the response generally dependent on the ratio of UV-B to UV-A (Teramura,1983; Tevini and Teramura,1989; Middleton and Teramura,1994).Some species show sensitivity to present levels of UV-B irradiance (Bongenrieder and Klein,1982) while others are apparently unaffected by rather massive UV-B enhancements (Becwar *et. al.*,1982). One third to one half of all plant species tested are deleteriously affected by above ambient UV-B levels (Sullivan, 1992). In contrast to detailed studies of UV-B radiation responses little is known about the biological effects of IR radiation, since infrared radiation showed positive effects in cosmetic, wellness purposes and dermatology (Lee *et. al.*,2006) but very meagre information about effects on plants physiological aspects are available. In the present scenario the use of herbal and ayurvedic medicines are increasing at a very

rapid rate because they are accessible, affordable, and culturally appropriate sources of primary health care for more than 80% of Asia's population (WHO). India exports herbal products and medicine to the tune of Rs550 crores annually. Out of 80,000 tonnes of medicinal plants imported by western countries, India tops the list of exporters to USA and Europe with a share of over 10,000 tonnes. The value of trade in medicinal plants is about Rs 5,000 crores while the world trade is about US \$ 62 billions. A survey indicated the use of herbal medicines will reach to the tune of US \$ 5 trillions during 2050. Currently, the ayurvedic and herbal products turnover is estimated to be Rs 25,000 crores. *Withania somnifera* (L.)Dunal, is also an important medicinal plant, belongs to family Solanaceae, popularly known as Ashwagandha or Wintercherry (Andallu and Radhika,2000). It is described as herbal tonic and health food in vedas and considered as 'Indian Ginseng' in traditional Indian system of medicine (Singh *et. al.*,2001). It is generally used as anti-inflammatory, anti-cancer, anti-stress and immunomodulator, adaptogenic, central nervous system, endocrine and cardiovascular activities respectively (Bhattacharya *et. al.*,1997a; Mohanty *et. al.*,2004; Ahmed *et. al.*,2005). Therefore from medicinal as well as economical point of view ashwagandha's overproduction will be a boon for the future scenario of India. Due to its heavy consumption in pharmacology, ashwagandha is underproduced crop and included in endangered species in Red-Data Book. So higher productivity with superior quality of Ashwagandha is essential. The present study therefore aimed to highlight the Influence of IR radiation counterfered with supplemented UV-B radiation to increase the growth and yield of Ashwagandha.

2. Material and Methods

Seeds of Ashwagandha were collected from IARI (Indian Agricultural Research Institute), New Delhi, treated with 0.1% HgCl₂ (Mercuric Chloride), washed with fresh water and finally with distilled water, then sown in field in five different plots. The crop was grown under UV-B and IR radiation separately and counteracted with each other i.e. Control, IR, UV-B, IR+UV-B, UV-B+IR respectively treatment was given at regular intervals of 15 days from germination till maturity. For growth and productivity method adopted by Kumar (1981) and Singh *et al.*, (1975) were adopted respectively.

3. Result and Discussion

Plants are affected by solar radiation differently on different regions of earth i.e. from temperate to tropical regions and from species to species. The results revealed that maximum promoted (1.435 times of control) root length observed with UV-B treatment after that 1.076 times growth observed under IR treatment as of control, while declined (0.98 times of control) root length observed under IR+UV-B and 0.89 times of control observed under UV-B+IR treatment as shown in table 1 and fig.1. This shows that marked increase observed under UV-B and IR treatment separately for 1h each. The result is consistent with Kumar and Ambrish (1992), studied that for shorter duration UV-B is promoting in legume crops and Geeta *et al.*, (2014) in *Capsicum annum* showed positive effects of UV-B radiation on different plant parts.

Fresh weight of root as shown in table 1 and fig.3 found inclined by 224%, 146% and 113% under UV-B+IR, IR+UV-B and IR treatments respectively as of control but marked decline of 24% with control observed under UV-B treatment. Dry weight of root was promoted maximum by 274% in UV-B+IR treatment and 174% and 118% observed under IR+UV-B and IR treatment but decline of 76.84% observed in UV-B treatment, shown in table 1 and fig.4. These were in accordance with Pal *et al.*, (1995) in *Vigna radiata* L. Wilczek but Zavala and Botto (2002) studied the increased biomass in *Raphanus sativus*, since radish is a kharif crop. Muleo and Morini (2008) observed the maximum fresh and dry weight in M9 apple under red light treatment.

A perusal of our results for stem growth parameters viz. length, fresh weight and dry weight suggests that there is maximum growth under UV-B+IR treatment by 177.34%, 256% and 236.36% respectively as compared with control as shown in table 1 and fig. 4 and 5. There is also a marked increase in other treatments as compared to control. Length of shoot increased under UV-B, IR+UV-B and IR treatment as 176.87%, 176.4% and 154.9% respectively as shown in table 1 and fig.1. Table 1 and fig.3 and 4 showed that the fresh weight and dry weight with IR+UV-B treatment increased by 223.67% and 181.82% respectively. Fresh weight and dry weight enhanced by 191.12% and 116.88% with UV-B

treatment and by 233.14% and 154.55% under IR treatment. The above result were consistent with Al-Oudat *et al.*, (1998) and Muleo and Morini (2008).

Results obtained for leaf shows that maximum promotory effect shown in UV-B+IR treatment except for leaf area index. Table 1 and fig 2,3 and 4 showed number of leaves, fresh weight and dry weight increased by 149%, 269.41% and 224.12% respectively. Under IR treatment promotory effect in number of leaves by 166.92% showed, after that under UV-B+IR, UV-B and IR+UV-B showed 149%, 146.4% and 135.11% respectively as compared with control. Growth in fresh and dry weight observed higher in UV-B+IR followed by IR+UV-B, UV-B and finally by IR as (269.41% and 224.72%), (200.86% and 156.93%), (187.4% and 104.87%) and (166.67% and 115.73%) respectively. The leaf area index showed in table 1 and fig 5 declined with all the four treatments. Maximum decline studied under UV-B+IR treatment by 56.98% followed by IR+UV-B, IR and UV-B as 71.8%, 85.8% and 91.89%. Saebo *et al.*, (1995) and Pal *et al.*, (1998) in Mustard cultivar are in favor of above result.

Table 1 and fig. 2, 3 and 4 showed in control flowering stops at the maturity of the crop and decline in fruit growth pattern as compared with control. Fruit under UV-B and IR treatment were diminished after 90 days but UV-B+IR and IR+UV-B showed declination by (34.79%, 40% and 41.17%) and (8.8%, 7.43% and 8.2%) respectively on maturity.

Table 1: Counteracting effect of Infra-Red radiation supplemented with UV-B radiation on growth of *Withania somnifera* (L.) Dunal.

Treatment	Parameter	Root	Stem	Leaf	Flower	Fruit
Control	Length, cm/ No.	15.8	42.8	133	-	30.67
	T1 Fw,g	7.8	16.9	16.38	-	3.5
	Dw,g	1.9	3.85	2.67	-	0.61
	Leaf area index			30.36		
IR	Length, cm/No.	17	66.3	222	33.67	18
	T2 Fw,g	8.8	39.4	27.3	1.33	1.5
	Dw,g	2.25	5.95	3.09	0.27	0.14
	Leaf area index			26.05		
UV-B	Length, cm/No.	22.67	75.5	194.67	11.3	14
	T3 Fw,g	5.9	32.3	30.7	0.028	1.5
	Dw,g	1.46	4.5	2.8	0.003	0.11
	Leaf area index			27.9		
IR+UV-B	Length, cm/No.	15.5	75.5	179.7	41.3	2.7
	T4 Fw,g	11.4	37.8	32.9	0.35	0.26
	Dw,g	3.3	7	4.19	0.072	0.05
	Leaf area index			21.8		
UV-B+IR	Length, cm/No.	14.1	75.9	198.3	64	10.67
	T5 Fw,g	17.48	43.32	44.13	1.62	1.4
	Dw,g	5.2	9.1	6	0.03	0.247
	Leaf area index			17.3		



Diag. Counteracting effect of IR and UV-B radiation on full plant length

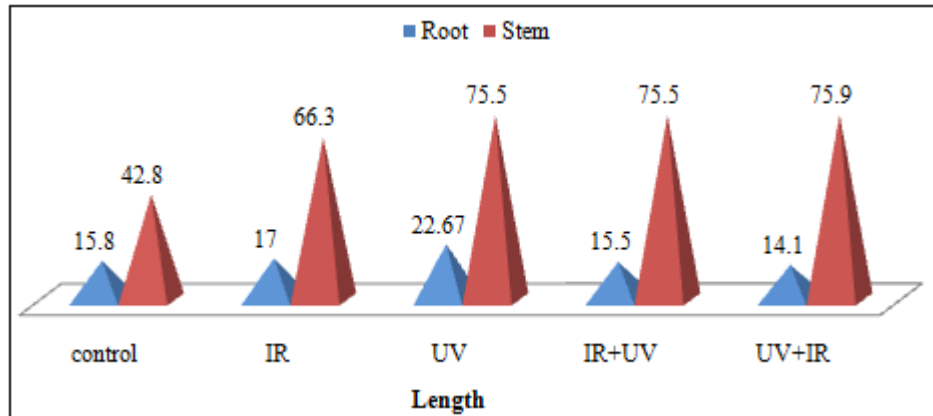


Fig.1 Counteracting effect of UV-B and IR radiation on root and shoot length of *Withania somnifera* (L.) Dunal

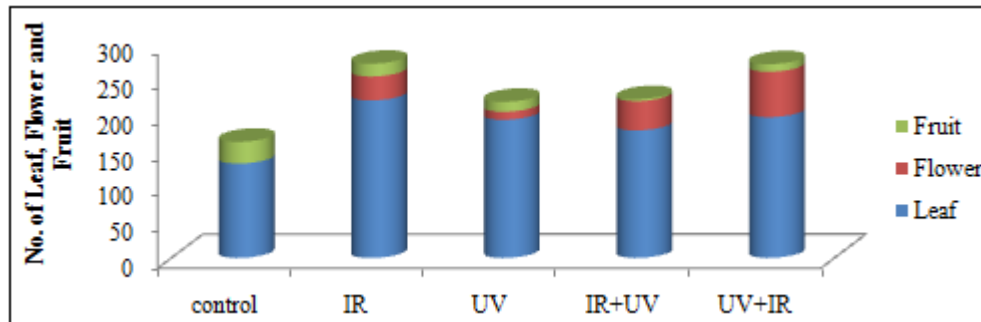


Figure 2: Counteracting effect of UV-B and IR radiation on number of leaf, flower and fruit of *Withania somnifera* (L.) Dunal

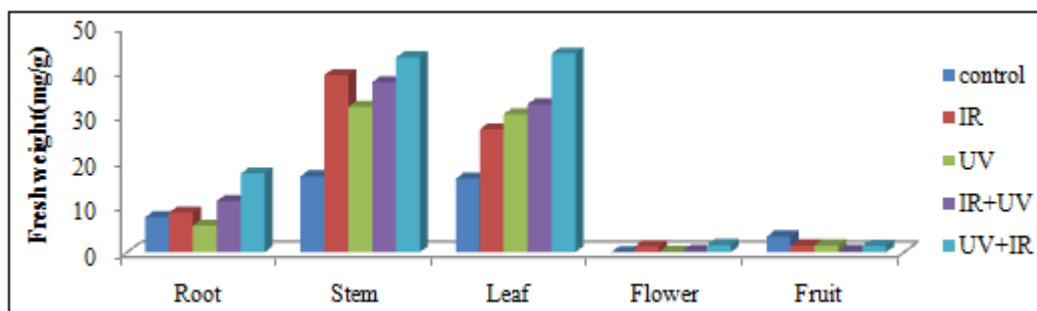


Figure 3: Counteracting effect of UV-B and IR radiation on fresh weight (mg/g) of root, stem, leaf, flower and fruit of *Withania somnifera* (L.) Dunal

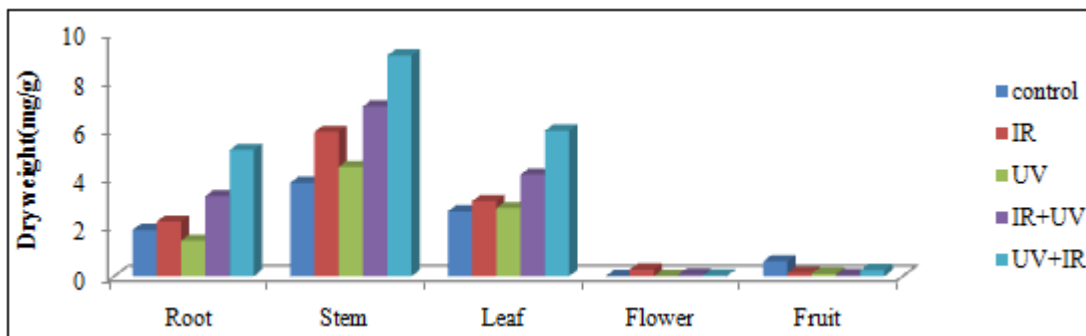


Figure 4: Counteracting effect of UV-B and IR radiation on dry weight (mg/g) of root, stem, leaf, flower and fruit of *Withania somnifera* (L.) Dunal

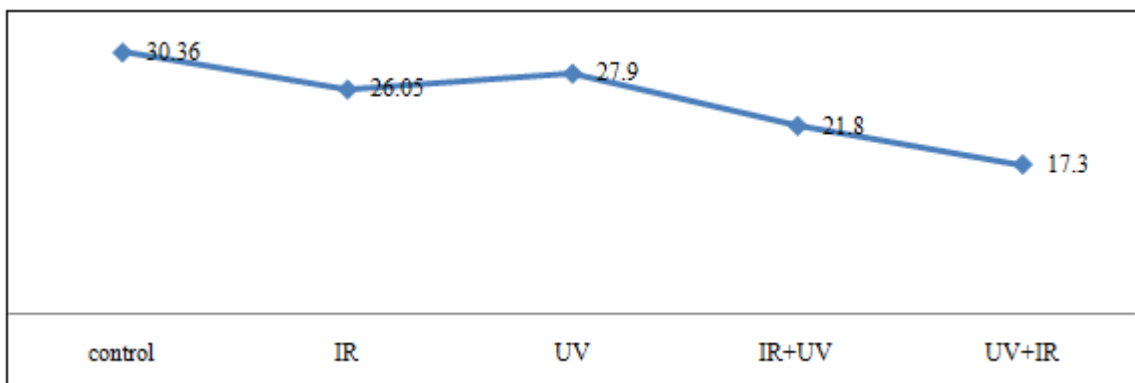


Figure 5: Counteracting effect of IR and UV-B on leaf area index of *Withania somnifera* (L.) Dunal

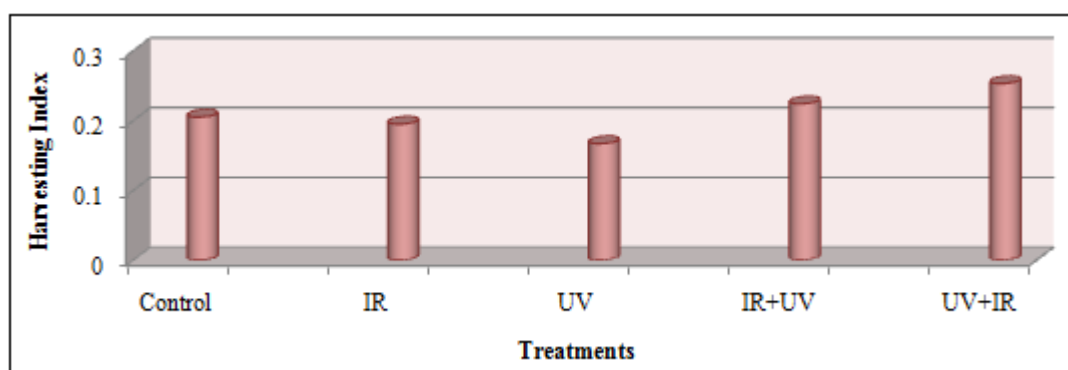


Figure 5: Counteracting effect of UV-B and IR radiation on Harvesting index of *Withania somnifera* (L.) Dunal

Table 2: Counteracting effect of Infrared radiation supplemented with UV-B radiation on yield attributes of ashwagandha (*Withania somnifera* (L.) Dunal)

Treatment	Total	Biomass(g/plant)		Harvesting
		Root		Index
Control	9.27	1.9		0.205
IR	11.56	2.25		0.195
UV-B	8.763	1.46		0.167
IR+UV-B	14.712	3.3		0.224
UV-B+IR	20.577	5.2		0.253

The yield of a plant is determined by the economically important part of the plant. In ashwagandha the economically important parts are roots. Harvesting index is the indicator of the compartmental transfer of biomass. Crop harvesting index was affected in all the treatments. Harvesting index as shown in table2 promoted maximum under UV-B+IR treatment by 123.42% and by 109.27% under IR+UV-B treatment as with control but decline by 95.12% and 81.46% with IR and UV-B treatment was studied with control. The present results were supported by

Gao et al., (2003) in cotton (*Gossypium sps*). Therefore the counteracting treatments of supplemental UV-B and IR radiation are beneficial from growth and yield point of view as compared to the separate treatments of UV-B and IR radiation.

4. Conclusion

As we see that counteracting effect of infrared radiation and supplemental ultraviolet-B radiation increase the growth and yield of the *Withania somnifera* (L.) Dunal. Therefore it will help India to strong the economy as well as health of poor and ultimately act as boon for the future of India.

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