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IMPACT OF COAL FLY ASH ON THE GROWTH OF *ANDROGRAPHIS PANICULATA* (BURM. F.) WALL. EX NEES.

Sameer Kant Shrivastava, S. V. K. Prasad* and V. K. Kanungo
Govt. Science College, Raipur, Chhattisgarh state, India
*Govt. K.D. Girls College, Rajnandgaon, Chhattisgarh state, India

ABSTRACT

Growth behaviour of *Andrographis paniculata* (Burm. f.) Wall. ex Nees. (common name: Kalmegh/Kalpnath) has been studied with reference to the application of various levels of fly ash such as 0% (control), 2%, 4%, 6%, 8%, 10%, 25%, 50%, 75% and 100% under pot culture conditions. Growth characteristics such as plant height, number of leaves, leaf area per leaf, leaf area per plant, fresh biomass, dry biomass (oven dried at 105°C for 24 hours), % moisture content, chlorophyll *a* & *b* and carotenoids were studied at the age of 60 days. All the growth characteristics were increased by 10 % fly ash incorporation into soil, whereas there was a continuous decline with higher doses of fly ash, i.e., 25%, 50%, 75% and 100% fly ash addition to soil.

INTRODUCTION

Thermal power stations use pulverized coal as fuel and produce enormous quantities of coal fly ash as a byproduct of combustion. A 1000 MW power station with a normal daily consumption of 12000 tones of coal produces about 2400 tones of fly ash a day (Chen et al. 2005). At present, about 80 thermal power stations in India produce nearly 100 million tonnes of coal ash per annum (Pandian 2004). The huge quantity of fly ash produced in coal based thermal power plants poses a serious disposal and environmental problems. Its deposition on leaves inhibits the normal transpiration and photosynthesis of plants (Gupta et al. 2002). Most industrial by-products act as pollutants, yet some may be used profitably in agriculture provided that they are used scientifically and judicially (Raman et al. 1997). Fly ash is rich in various essential and non-essential elements but poor in nitrogen, available phosphorus and organic carbon (Gupta et al. 2002, Vijayan 2000). Thus, it appears that fly ash materials have potential resources for the agricultural activities. The utilization of fly ash in India is considerably low (3-5%) when compared to developed countries (Vijayan 2000).

Use of fly ash in agriculture improves various physico-chemical properties of soil, particularly the water holding capacity and available plant nutrients (Mandal & Saxena 1998). The addition of appropriate quantities of fly ash can alter and improve the physico-chemical properties of soil such as pH, moisture, texture, bulk density, porosity, electrical conductivity, total dissolved salts, water holding capacity and available plant nutrients (Ajaz & Tiyagi 2003, Ajaz et al. 2004, Capp 1978, Chang et al. 1977, Fail & Wochock 1977, Gangloff et al. 2000, Grewal et al. 2001, He et al. 1999, Jala et al. 2006, Khan & Khan 1996, Khan et al. 1997, Lalk et al. 1996, Mandal & Saxena 1998, Matsi & Keramidas 2001, Mozaffri et al. 2002, Page 1980, Sharma et al. 2001, Singh et al. 1994). Impact of fly ash incorporated soil on seed germination, seedling growth, yield and various growth characteristics such as plant height, number of leaves, leaf area, fresh and dry biomass and photosynthetic pigments of several crop plants such as cucumber, maize, rice, soyabean, tomato, pearl millet, wheat, sunflower, rye, barley, chilli, egg plant, mustard, groundnut, beet root, sorghum, gram, spinach, rye grass, agropyron, trifolium, teak, trigonela and amaranthus has been studied under pot

culture, green house and field conditions by several workers (Ajaz & Tiyagi 2003, Ajaz et al. 2004, Cline et al. 2000, Fox 1990, Grewal et al. 2001, Hammermeister et al. 1998, He et al. 1999, Kene et al. 1991, Khan & Ghadirpour 1999, Khan & Khan 1996, Khan et al. 1997, Khan & Singh 2001, Kuchanwar & Matte 1997, Lalk et al. 1996, Li et al. 2001, Malewar et a1. 1999 a, 1999 b, Matsi & Keramidas 1999, Masilmani & Dharmalingam 1999, Naveen et al. 1998, Prasad & Panda 2002, Sajwan et al. 1995, Sajwan et al. 1996, Sale et a1. 1996, Sharma et al. 2001, Sims et al. 1995, Singh et al. 1994, Su et al. 1997, Summers et al. 1998, Tripathi & Shau 1997, Vijayan & Behara 1999, Wong 1995, Wong & Su 1997, Wong et al. 1998).

The medicinal properties of *Andrographis paniculata* have been given by Kirthikar & Basu (1984) and Varier (1994). The quantity and method of fly ash use vary with soil types, the plant to be grown, existing agroclimatic conditions and the type of available fly ash (Adriano 1986, Fury et al. 1976). Therefore, the present experiments were conducted to analyse the impact of various doses of fly ash incorporation to soil on growth behaviour of *Andrographis paniculata* (Burm. f) Wall. ex Nees.

MATERIALS AND METHODS

Various fly ash concentrations to soil viz., 0% (control), 2%, 4%, 6%, 8%, 10%,25%, 50%, 75% and 100% were prepared as treatments Tl, T2, T3, T4, T5, T6, T7, T8, T9 and TI0 in pot culture conditions during August 2006 to February 2007. *Andrographis paniculata* was grown as kharif crop. Fly ash was collected from coal fired thermal power plant of ACC Ltd. at Jamul. Pots of 20 cm height and 24 cm diameter were filled with the well mixed combinations of fly ash and soil. Twenty seeds of *Andrographis paniculata* per pot were sown and grown in three replicates for each treatment. The growth characteristics such as plant height, number of leaves, leaf area per leaf, leaf area per plant, fresh and dry biomass (oven dried at 105°C for 24 hours), % moisture, chlorophyll *a & b* and carotenoid contents were recorded at the age of 60 days. Leaf area was determined by using graph paper. Chlorophyll *a & b* and carotenoid contents were measured as described by Arnon (1949) and Duxbury & Yentsch (1956).

RESULTS AND DISCUSSION

The growth characteristics of *Andrographis paniculata* under the influence of various fly ash concentrations are given in the Table l. The data reveal that there was a continuous increase in all the growth parameters with 10% fly ash application. A continuous decline at higher fly ash application was observed in growth of the plants. There is no significant variation in % moisture content. Inhibition of growth parameters was found to be more under the stress of 50%, 75% and 100% fly ash application. The similar results were observed in other plants also under the influence of fly ash (Ajaz & Tiyagi 2003, Ajaz & Tiyagi 2004, Fox et al. 1990, Kene et al. 1991, Khan et al. 1997, Khan & Ghadirpour 1999, Khan & Khan 1996, Khan & Singh 2001, Lalk et al. 1996, Malewar et al. 1999 a and 1999 b, Matsi & Keramidas 1999, Sale et al. 1996, Su et al. 1997, Summers et al. 1998, Tripathy & Sahu 1997, Wong 1995, Wong et al. 1998).

Khan & Singh (2001) pointed out that tomato plants grown in ash treated plots have luxuriant growth, greener foliage as well as increase in yield of three cultivars. Ajaz & Tiyagi (2003) concluded that incorporation of fly ash to soil caused significant improvement in plant growth, leaf area and photosynthetic pigments of cucumber. According to Tripathy & Sahu (1997), the growth characters of wheat in terms of plant height, leaf number, leaf area and dry weight were increased with

Table 1: Impact of coal fly ash on growth characteristics of *Andrographis paniculata* at the age of 60 days (values are mean of three replicates).

Growth Characteristics	Treatments												
	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	Mean	S.D.	S.E.
Plant height (cm)	8.9	9.6	12.3	15.6	16.4	18.2	8.2	7.7	6.9	6.4	11.08	4.42	1.39
No. of leaves/plant	43	46	67	73	85	91	38	35	31	27	53.6	23.38	1.39
Leaf area/ leaf (cm^2)	4.26	4.91	6.41	8.43	9.44	12.04	3.9	3.15	2.86	2.66	5.81	3.19	1.0
Leaf area/ plant (cm^2)	183.2	225.9	429.5	615.4	802.4	1095.6	148.2	110.2	88.7	71.8	377.3	352.3	111.4
Plant fresh weight (g)	3.32	4.28	6.25	6.75	7.99	8.73	2.87	2.63	2.3	1.95	4.71	2.51	0.79
Plant dry weight (g)	0.65	0.75	1.04	1.08	1.16	1.22	0.58	0.54	0.5	0.45	0.8	0.3	0.09
Moisture content of the plant,%	80.42	82.47	83.36	84	85.48	86.02	79.79	79.46	78.26	76.92	81.62	3.1	0.98
Chlorophyll-*a* (mg g^{-1} d.m.)	2.39	2.42	2.48	2.52	2.56	2.67	2.21	2.18	2.13	2.12	2.37	0.2	0.06
Chlorophyll-*b* (mg g^{-1} d.m.)	1.56	1.59	1.64	1.76	1.81	1.87	1.43	1.41	1.38	1.2	1.57	0.21	0.06
Total chlorophyll (mg g^{-1} d.m.)	3.95	4.01	4.12	4.28	4.37	4.54	3.64	3.59	3.51	3.32	3.93	0.41	0.13
Carotenoid (mg g^{-1} d.m.)	0.81	0.87	0.93	0.95	1.02	1.12	0.75	0.74	0.69	0.63	0.85	0.16	0.05
Total photo-synthetic pigments (mg g^{-1} d.m.)	4.76	4.88	5.05	5.23	5.39	5.66	4.39	4.33	4.2	3.95	4.78	0.55	0.17

the application of 50% fly ash under pot culture conditions. Khan & Ghadirpour (1999) showed an increase in chlorophyll and carotenoid content of chilly and tomato plants with the application of fly ash at 0.6 kg/m^2 under field conditions. Ajaz & Tiyagi (2004) stated that fly ash influenced the plant growth parameters such as plant length, fresh and dry weights, leaf area and photosynthetic pigments of bottle gourd. Fly ash application enhanced plant growth, leaf pigments and plant weight of tomato plants (Khan et al. 1997). Sale et al. (1996) observed that 6.25 % to 12.5 % fly ash application increased plant height. Fox et al. (1990) revealed that 2% fly ash application increased dry matter yield of *Trifolium subterraneum* c.v. Esperance under pot culture conditions. Ma1ewar et al. (1999 a &1999 b) found that plant dry weight of wheat, sunflower and spinach was highest in 1:3 fly ash: soil mixtures, while in sorghum dry weight was highest in 3:1 fly ash under pot culture conditions. Matsi & Keramidas (1999) noted increased dry matter yield of rye grass with the application of fly ash under pot culture conditions. Su et al. (1997) and Wong et al. (1998), while working with *Agropyron elongatum* with the application of 10% fly ash to soil under pot culture conditions, found improvement in plant dry weight with fly ash application. Lalk et al. (1996) noticed that 16% fly ash application increased dry matter yield of soyabean under pot culture conditions. Kene et al. (1991) showed that 10% fly ash application had beneficial effects on growth and yield performance of sunflower c.v. Horden in pot culture experiments. Khan & Khan (1996) stated that pusaruby plants grown in pots containing the ash soil mixture showed luxuriant growth with bigger and greener

leaves. Plant growth, leaf carotenoid and chlorophyll concentration were mostly enhanced in the treatments with 40-80% fly ash. Wong (1995) concluded that total dry weight yields of *Agropyron* in ash amended pots were significantly increased as compared to the control without ash amendment.

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