

# EFFECT OF FLY ASH EXTRACT ON SEED GERMINATION AND SEEDLING GROWTH OF GARDEN PEA

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**Abstract:** Fly ash disposal and utilization shall continue to be an important area of national concern due to India's dependence on thermal power generation for its energy supply. Fly ash accumulation creates environmental pollution and health hazards. Due to increasing environmental concern and growing magnitude of the problem it has become imperative to manage fly ash. Fly ash is rich in many macro and micro plant nutrients. In laboratory bioassays, the influence of different concentrations (0, 25, 50, 75 and 100%) of fly ash extract was studied on seed germination and seedling growth of Azad P<sub>1</sub>, E<sub>6</sub>, Arkel and PSM cultivars of *Pisum sativum* L. Pea varieties responded positively to fly ash aqueous extract. Fly ash aqueous extract with increasing concentration (25-75%) stimulated the seed germination and seedling growth as compared to control. Maximum stimulation was recorded for root and shoot length and their dry matter accumulation at 50% extract concentration. Extract concentration above 75% significantly inhibited the early growth. Stimulation of early growth of garden pea by fly ash extracts points towards its utilization for soil amendments.

**Keywords:** Disposal, Fly ash, Germination, Growth, Nutrients

## INTRODUCTION

In thermal power plants (TPPs) coal is used to produce energy and in the process, a huge amount of fly ash is generated. Currently some 120 million tonnes of fly ash is produced every year from 85 TPPs in the country (Jala and Goyal, 2006). It is likely to exceed 170 million tonnes per year by the end of 11<sup>th</sup> five year plan with the annual growth in the energy demand. Management of fly ash is a major environmental and economic concern all over the world. Presently 65,000 acres of land is occupied by ash ponds in India containing 800 million tonnes of ash which is a waiting resource to be utilized (Anandakumar, 2005). Fly ash consists of practically all the elements present in the soil except organic carbon and nitrogen (Kumar *et al.*, 1998, 2000). This makes it a suitable material that can be used as an additive/amendment material in agricultural applications (Kalra *et al.*, 2000, 2003).

National Capital Power Station, Dadri is the front runner thermal power station of western Uttar Pradesh with a capacity of 840 MW situated in district Gautam Budh Nagar. This power plant produces more than 3000 tonnes of fly ash daily. Laboratory bioassays were conducted to study the effect of fly ash on the

seed germination and seedling growth of garden pea with the objective to develop an eco-friendly technology for utilization of fly ash in agricultural applications.

## MATERIAL AND METHODS

Fly ash was collected from National Capital Power Station, Dadri. In laboratory bioassays, the influence of different concentrations (0, 25, 50, 75, 100%) of fly ash extract was studied on seed germination and seedling growth of Azad P<sub>1</sub>, E<sub>6</sub>, Arkel and PSM cultivars of *Pisum sativum* L.

## PREPARATION OF FLY ASH EXTRACT

To prepare fly ash extract 100 gm of ash was soaked in 500 ml of distilled water (1:5 W/V) on dry weight basis for 24 hours at room temperature. The contents were shaken thoroughly at regular intervals. The extract was filtered first through three layers of muslin cloth and then through two layers of Whatmann No. 1 filters paper. A clear solution was thus obtained. The filtrate was treated as 100 % concentration. It was diluted with distilled water to prepare 75, 50 and 25 % concentrations.

## METHODOLOGY OF BIOASSAY

The seeds of all the test cultivars were disinfected with 0.1 % HgCl<sub>2</sub> solution for 1 minute and then washed 5-6 times with distilled water to remove all traces of HgCl<sub>2</sub> and then seeds were dried with filter paper. Sterilized petridishes (6 cm dia.) were lined with two filter papers at the bottom. 20 seeds of each test cultivars were kept equidistant on the top of the filter paper in separate petridishes. In each petridish, the filter paper was wetted with 3 ml extract and control distilled water was used. The filter papers were kept moist by adding 2 ml extract/distilled water in each petridish on 2<sup>nd</sup>, 4<sup>th</sup>, 6<sup>th</sup>, 8<sup>th</sup> and 10<sup>th</sup> day of sowing. The petridishes were kept in BOD incubator at 20 ± 2°C. Each treatment was replicated thrice. The germination was recorded at 2<sup>nd</sup>, 4<sup>th</sup>, 6<sup>th</sup> and 8<sup>th</sup> day and seedling growth (root and shoot length and dry matter accumulation) on 10<sup>th</sup> day after sowing (DAS). For determining seedling growth, 10 randomly selected seedlings from each petridish were taken and their mean values were used for statistical analysis. After measuring root and shoot length, the seedlings were dried in an oven at 70°C till the weight become constant for determining dry weight accumulation. Then they were weighed on digital balance.

## GERMINATION RELATIVE INDEX (GRI)

GRI was calculated by the following formula:

$$\text{GRI} = (S) \times n / (Kn - n)$$

Where,

Xn = no. of germinated seeds on n<sup>th</sup> day

K = no. of counts

n = number of days

## Vigour index (VI)

It was determined according to ISTA (1976):

VI = Germination percent x (shoot length + root length)

## RESULTS AND DISCUSSION

In the present study, the effect of 25, 50, 75 and 100 % concentrations of fly ash extract was investigated on the seed germination and seedling growth of four pea cultivars Azad P<sub>1</sub>, E<sub>6</sub>, Arkel and PSM under laboratory conditions.

All the four pea cultivars responded positively to fly ash aqueous extract and showed more or less similar response. A corresponding reduction in seed germination and seedling growth was noticed with the increase in concentration of the extract (75 % to 100 %) in all cultivars under study (Table 1,2). The lower concentrations of fly ash extract (25 % and 50 %) were stimulatory for seed germination and seedling growth. In higher concentrations of the extract (75 % and 100 %), effects were inhibitory. The maximum reduction was observed in 100 % extract of the ash. The growth of root and shoot also recorded a significant decrease with the increase of the extract concentration beyond 50 %. The excess amount of salts in the fly ash extract has inhibitory effects on germination (Pandeya *et al.*, 1968). The high concentration of salts (salinity) creates high osmotic pressure in the medium, thus decreasing uptake of water and minerals. Similar observations were made by Prassanakumar *et al.* (1997), Kumar and Bajwa (1997), Saravanan and Appavu (1998), Subramani *et al.* (1998) and Kuligod *et al.* (2000). Mer *et al.* (2000) also reported the inhibitory effects of salinity on the seed germination and seedling growth of *Cicer arietinum*, *Brassica juncea*, *Triticum aestivum* and *Hordeum vulgare*. Germinating seeds are also very sensitive to H<sup>+</sup> ion concentration in the medium, even a slight change in the pH level may lead to a significant reduction in germination (Baruah *et al.*, 1993; Sinha, 1993; Verma, 1999).

In all the four cultivars of pea, germination % was maximum in 25 % extract concentration and seedling growth in 50 % extract concentration (Table 1&2). The low concentration of salts does not create high salinity and do not inhibit the absorption. The availability of mineral nutrients in sufficient amount and a normal absorption due to the enhancing property of HCO<sub>3</sub><sup>-</sup> results in better germination percentage and seedling growth (Singh, 1982). Higher values for vigour index (VI), growth relative index (GRI) and response coefficient (RC) at 25 % extract concentration further suggest the suitability of lower extract concentrations for germination and early growth of pea cultivars. Stimulation of early growth of garden pea by fly ash extracts points towards its utilization for soil amendments.

**Table 1.** Effect of fly ash extract on germination and early growth of Azad P<sub>1</sub> and E<sub>6</sub> cultivars of *Pisum sativum* L.

Characters	Germination (%)	Root length (cm)	Shoot length (cm)	Total length (cm)	Dry weight of root (gm)	Dry weight of shoot (gm)	Dry weight of residual seed (mg)	GRI	VI	RC
FA extract conc. (%)										
<b>Azad P<sub>1</sub></b>										
<b>0</b>	85.00	5.65	5.70	11.35	27.48	27.56	96.35	221.00	964.75	
<b>25</b>	95.00	6.58	6.67	13.25	28.57	28.78	98.14	247.00	1258.75	0.167
<b>50</b>	93.30	6.71	6.83	13.54	28.88	28.94	98.87	241.80	1263.28	0.192
<b>75</b>	86.60	5.84	3.36	9.20	27.61	22.46	95.84	224.90	796.72	-0.189
<b>100</b>	81.60	4.85	3.14	7.99	26.32	22.17	94.91	211.90	635.66	-0.313
<b>CD at 5 %</b>	4.164	0.504	0.682	0.663	0.751	1.179	0.700	6.558	42.496	0.061
<b>E<sub>6</sub></b>										
<b>0</b>	96.60	8.46	5.68	14.14	26.56	27.44	82.68	14.14	1365.92	
<b>25</b>	100.00	9.52	6.26	15.78	27.68	28.66	84.75	15.78	1578.00	0.115
<b>50</b>	100.00	10.19	6.93	17.12	27.96	28.92	86.86	17.12	1712.00	0.210
<b>75</b>	96.60	7.81	5.48	13.29	27.76	27.18	82.94	13.29	1283.81	-0.060
<b>100</b>	90.00	6.94	4.86	11.80	27.52	26.64	82.15	11.80	1062.00	-0.165
<b>CD at 5 %</b>	3.251	0.609	0.439	0.704	0.831	1.032	0.949	0.704	52.115	0.022

**Table 2.** Effect of fly ash extract on germination and early growth of Arkel and PSM cultivars of *Pisum sativum* L.

Characters	Germination (%)	Root length (cm)	Shoot length (cm)	Total length (cm)	Dry weight of root (gm)	Dry weight of shoot (gm)	Dry weight of residual seed (mg)	GRI	VI	RC
FA extract conc. (%)										
<b>Arkel</b>										
<b>0</b>	100.00	8.32	5.76	14.08	30.64	30.82	98.42	260.00	1408.00	
<b>25</b>	100.00	8.54	5.95	14.49	30.86	30.95	99.54	260.00	1449.00	0.029
<b>50</b>	100.00	5.64	4.28	9.92	27.42	27.84	102.66	260.00	992.00	-0.295
<b>75</b>	95.00	4.36	3.62	7.98	26.34	22.68	98.94	247.00	758.10	-0.433
<b>100</b>	90.00	3.68	3.08	6.76	22.76	22.12	96.04	234.00	608.40	-0.519
<b>CD at 5 %</b>	2.971	0.513	0.527	0.710	0.544	0.649	1.177	6.695	85.363	0.054
<b>PSM</b>										
<b>0</b>	95.00	5.86	5.94	11.80	27.82	27.96	97.12	247.00	1121.00	
<b>25</b>	100.00	6.48	6.72	13.20	28.34	28.86	98.56	260.00	1320.00	0.118
<b>50</b>	100.00	6.82	6.95	13.77	28.95	29.14	99.74	260.00	1377.00	0.166
<b>75</b>	95.00	5.90	5.98	11.88	28.86	28.08	96.68	247.00	1128.60	0.006
<b>100</b>	85.00	4.74	4.86	9.60	27.64	26.78	95.22	221.00	816.00	-0.186
<b>CD at 5 %</b>	4.805	0.560	0.624	0.572	0.726	0.473	0.968	6.437	39.430	0.020

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