Indian J.Sci.Res. 16 (1): 43-50, 2017 ISSN: 0976-2876 (Print)
ISSN: 2250-0138(Online)

RESPONSE OF ARKEL AND PSM CULTIVARS OF GARDEN PEA IN FLY ASH AMENDED SOIL

ASHISH TEJASVI[1]
Department of Botany, Agra College, Agra ,U.P., India

ABSTRACT

Fly ash is the fine residue produced when coal is burnt in thermal power stations. The macro and micro nutrients present in coal get generally concentrated in the fly ash. Application of these CCP's (coal combustion products) mixed with composted organic materials onto soil can improve the soil's physico-chemical conditions and provide essential nutrients for better crop growth. Present study was conducted to evaluate the fly ash potential as a soil amendment for growth and yield of garden pea (*Pisum sativum* L.). Field experiments have been designed to study in depth the application of fly ash, organic manure like farmyard manure (FYM), biocompost (SOM) and chemical fertilizer (CF) in different combinations. Two pea cultivars Arkel and PSM were used in the study. The crop was raised as per appropriate agronomical practices. Different growth and yield parameters under different treatments were observed and recorded up to 90 DAS. Combined application of FA and CF with either FYM or SOM helped in improving the measured growth parameters as compared to FA alone and control. Application of organic material in conjunction with CF helped in improving nutrient supplying capacity of the soil which was further increased when FA was added as a soil amendment. Under adequate supply of nutrients, the observed growth parameters were enhanced. The positive outcome of the results of the present investigation is expected to encourage large scale use of fly ash in agriculture with an added advantage of decreasing environmental pollution; however, the changes in soil environment caused by fly ash incorporation need to be investigated on long term basis.

KEY WORDS: Biocompost, Coal, Fly ash, Garden pea, Growth

Due to increasing urbanization and industrialization day by day the energy requirements goes on increasing. To overcome those energy demands coal based thermal power plants producing a huge amount of fly ash by coal combustion. About 120 coal based thermal power stations in India are producing about 112 million tonne fly ash per year. With the increasing demand of power and coal being the major source of energy, more and more thermal power stations are expected to be commissioned / augment their capacities in near future. As per the estimates, fly ash generation is expected to increase to 225 million tonne by 2017 (Kumar *et al*. 2005). Regular and periodic augmentation of fly ash reserve keeps on policy makers busy to plan for more and more area for disposal at the cost of finite land resources and techno-economically feasible and eco-friendly ways of utilization (Singh *et al*. 2011). Moreover, one can never afford to leave associated environmental problems unattended. The physical and chemical properties of a particular fly ash are dependent on the composition of the parent coal, conditions during coal combustion, efficiency of emission control devices and practices used during storage and handling (Adriano *et al*. 1980). Fly ash is rich in several micro and macro plant nutrients. Now a days, Fly Ash Utilization Programme (FAUP) in varying agro-climatic conditions and different soil-crop combinations supported with laboratory investigations have shown significant increase in yields of edible parts as well as biomass without any adverse impact on soil health (Kumar *et al*. 2005).The present investigation was therefore, conducted to study the effect of different sources of fertilizers applied in an integrated manner on crop productivity, restoration on soil fertility and minimization of environmental hazards.

MATERIALS AND METHODS

Fly ash was collected from National Capital Power Station, Dadri located in Gautam Budh Nagar District of Western Uttar Pradesh (India). Field experiments were carried out at a farmer's field near Meerut with sandy loam soil. Two cultivars of pea (*Pisum sativum* L.) viz. Arkel and PSM were used as test crop. Fly ash, organic manure like farmyard manure (FYM), biocompost (Simbhaoli Organic Manure, SOM) and chemical fertilizers (CF) were used in different combinations. Fly ash @ 10 t/ ha, FYM @ 603 Kg/ ha and SOM @ 350 Kg/ ha was applied. Total eight treatment combinations used in this study were: Control (without any application), CF (recommended dose), FA (fly ash alone), CF+FA, CF+BC, CF+FYM, CF+FA+BC and CF+FA+FYM. Experimental plots (2m× 2m) were

[1]Corresponding Author

prepared using above treatment combinations and replicated thrice in randomized block design (RBD). A uniform nutrient level of 20 Kg N, 40 Kg P and 60 Kg ha^{-1} through these materials and chemical fertilizers was maintained for all the treatments except fly ash and control plots. Different growth and yield parameters viz. plant height, root length, no. of leaves/ plant, no. of branches/ plant, no. of pods/ plant, no. of seeds/ pod, pod length, biological yield, days to 50% flowering, days to maturity, seed yield/ plant, 100 seed weight, harvest index %, NPP (Net Primary Productivity), response coefficient, chlorophyll content were recorded on different intervals. The treated soils in which these plants are planted were analyzed for different physico- chemical parameters.

RESULTS AND DISCUSSION

It was observed that integrated use of organic materials favorably improved the soil physico- chemical parameters which in turn advantageous for the growth and yield parameters of two pea cultivars. The number of branches, number of leaves, root length, plant height, dry matter production and net primary productivity were influenced by the treatments and an increase was recorded up to 90 DAS (Table 1). Similar positive response was observed when FA in combination with organic materials was used for cultivation of pea by some earlier workers (Deepa and Poonkodi 2004; Garg *et al*. 2005; Ram *et al*. 2006; Gupta *et al*. 2007; Aggrawal *et al*. 2009; Yunusa *et al*. 2009; Jala and Goyal 2010; Tejasvi and Kumar 2011). Fly ash amendment showed most beneficial effects on the accumulation of chl. a,b and total chlorophyll at 60 DAS (Figs. 1& 2).

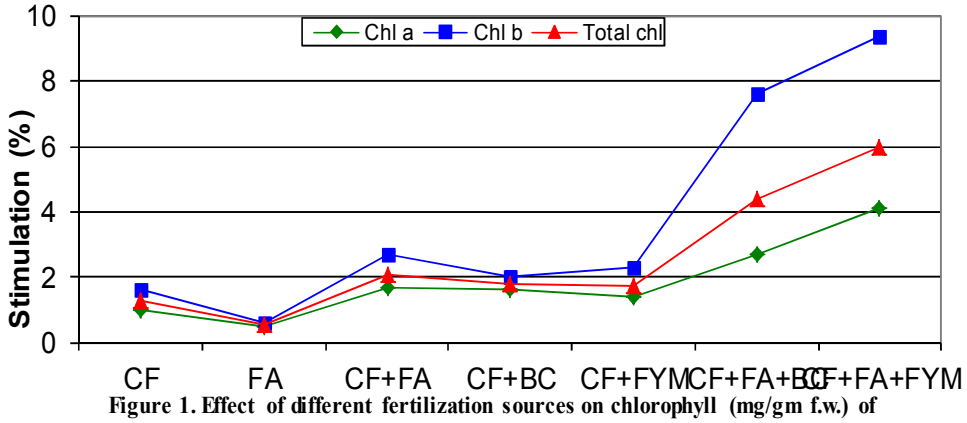

Figure 1. Effect of different fertilization sources on chlorophyll (mg/gm f.w.) of Arkel cultivar at 60 DAS

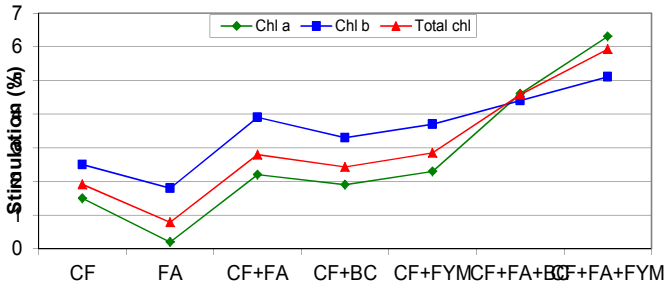

Figure 2. Effect of different fertilization sources on chlorophyll (mg/gm f.w.) of PSM cultivar at 60 DAS

Similar observations also have been made by Gupta *et al*. 2004; Patil and Chaudhari 2004; Singh and Gupta 2005; Yunusa *et al*. 2008; Nalawade *et al*. 2009. In the present study, days to 50% flowering and days to maturity gets reduced for two pea cultivars in fly ash amended soil as compared to control. Similar observations were made by Kumar *et al*. (1998). It is evident from data that there was sufficient increase in the number of pods per plant, seeds per pod, size of pods and 100 seed weight in all supplements as compared to FA alone or control (Table 1). The increase was more significant when either FYM or SOM was applied with CF and FA. These results are in conformity with those of Sajwan *et al*. 1995; Kruger and Surridge 2009; Karmaker *et al*. 2009. There was significant increase in NPP in all soil amendments as compared to control. In fly ash amended soil, an increase of 38.88 % and 54.76 % in NPP was recorded over control in Arkel and PSM, cultivars respectively. The maximum increase in NPP was observed in combined application of organic materials, CF and FA (Table 1). A significant increase in dry matter accumulation was recorded in all soil amendments as compared to control (Table 1). In fly ash amended soil, an increase of 30.04 % and 47.05 % was recorded over control in Arkel and PSM cultivars, respectively. The maximum phytomass was registered in combined application of organic materials, CF and FA where the increase in biological yield was 18.75 % and 26.20 % over the chemical fertilizers used alone in Arkel and PSM cultivars of pea, respectively. In fly ash amended soil, only a marginal increase in harvest index over control was recorded. But the increase was significant when organic materials were applied with CF and FA (Table 1).

Table 1. Effect of different fertilization sources on growth, yield attributes, yield and harvest index of Arkel and PSM cultivars of *Pisum sativum* L. at 90 DAS

Characters / Fertilization Sources	Root length (cm)	Plant height (cm)	No. of branches	No. of leaves	Days to 50 % flowering	Days to maturity	No. of pods/ plant	Pod length (cm)	No. of seeds/ pod	100 seed weight (gm)	Seed yield (gm)	Biological yield (gm)	Harvest Index	NPP (gm)
Arkel														
C	13.70	59.40	4.20	7.80	55.00	100.00	9.30	6.60	6.10	18.052	10.24	18.07	56.60	0.180
CF	14.20	94.50	5.10	14.50	53.00	99.00	13.40	7.00	6.50	20.416	17.78	27.23	65.20	0.27

														5
FA	13.90	93.00	4.80	12.10	51.00	94.00	11.60	6.60	6.30	19.384	14.16	23.50	60.20	0.2500
CF+FA	14.20	94.80	5.60	15.10	52.00	94.00	14.00	7.20	6.80	20.618	19.62	28.15	69.60	0.2999
CF+BC	14.30	97.50	5.50	15.40	53.00	99.00	14.20	7.20	6.70	20.740	19.73	28.46	69.30	0.2887
CF+FYM	14.20	97.10	5.40	14.70	55.00	98.00	14.00	7.20	6.70	20.655	19.37	28.05	69.00	0.2866
CF+FA+BC	14.40	103.00	5.90	18.60	53.00	93.00	15.30	7.50	7.00	22.246	23.82	32.42	73.40	0.3488
CF+FA+FYM	14.30	102.60	6.00	19.30	51.00	94.00	15.10	7.50	7.00	22.154	23.41	32.28	7.50	0.3433
CD at 5 %	N.S.	3.805	0.433	1.154	2.100	2.663	0.972	0.371	N.S.	0.595	0.295	1.999	0.694	0.0199
PSM														
C	14.40	76.50	5.50	9.70	52.00	97.00	9.20	5.90	5.50	17.842	9.02	16.305	55.30	0.1688
CF	15.30	94.20	6.40	15.30	52.00	97.00	14.40	7.00	6.50	19.086	17.86	28.055	63.60	0.2889
FA	14.90	90.10	6.00	13.20	49.00	92.00	13.00	6.60	6.00	18.642	14.54	23.970	60.60	0.2600
CF+FA	16.20	96.30	6.70	21.40	50.00	91.00	15.00	7.20	6.70	20.008	20.10	28.285	71.00	0.3100
CF+BC	15.70	97.50	6.70	19.10	51.00	96.00	15.80	7.10	6.60	19.725	19.91	28.650	69.40	0.2988
CF+FYM	15.90	96.70	6.90	18.60	52.00	96.00	15.10	7.00	6.60	19.688	19.62	28.455	68.90	0.2966
CF+FA+BC	16.50	103.40	7.40	23.70	51.00	91.00	17.40	7.30	7.00	22.956	27.96	35.895	77.80	0.3

														94
CF+FA+FYM	16.90	104.60	7.80	24.20	49.00	92.00	17.60	7.36	6.90	22.143	26.89	34.914	77.00	0.3799
CD at 5 %	0.978	3.429	0.559	1.063	2.327	2.989	0.695	0.398	0.678	0.650	0.482	1.661	0.756	0.0334

The increase recorded in harvest index was 28.4-29.7 % and 39.2-40.7 % in Arkel, PSM cultivars, respectively. The data on harvest index indicate that fly ash cannot replace chemical fertilizers but when supplemented with CF, it proved beneficial. The maximum harvest index was obtained in integrated nutrition supply system.

The physico- chemical properties of soil were improved when chemical fertilizer was supplemented with FA and FYM or SOM. Such integrated application decreased bulk density and increased organic carbon and pH of soil. Available nutrient content also gets increased under integrated nutrient supply system (Table 2).

Table 2. Effect of different modes of fertilization sources on physico-chemical properties of soil

Characters ▶ / **Fertilization Sources ▼**	**BD**	**pH**	**Organic carbon (%)**	**Nitrogen (Kg/ha)**	**Phosphorus (kg/ha)**	**Potassium (kg/ha)**
C	1.34	6.7	0.29	146.10	30.90	128.10
CF	1.32	6.8	0.27	174.40	41.20	168.30
FA	0.98	7.0	0.35	162.20	33.40	147.40
CF+FA	1.28	6.9	0.32	180.00	44.50	170.60
CF+BC	1.27	6.8	0.39	183.40	46.10	172.40
CF+FYM	1.25	6.7	0.38	185.20	45.80	173.50
CF+FA+BC	1.21	7.0	0.43	194.70	61.80	178.20

CF+FA+FYM	1.20	7.0	0.42	196.50	60.20	178.80

Similar findings were also made by Mittra *et al*. 2003; Yeledhalli *et al*. 2008; Tejasvi and Kumar 2012. Truter *et al.* (2001) also observed beneficial effect of SLASH (Fly ash + sewage sludge + lime) on plant growth and reported an increment of 200 % in maize, 240 % in triticale and 215 % in sorghum @ 10 % SLASH content in the soil. Sewage sludge application in the soil at the same rate increased dry matter production by 239 %, 370 % and 170 % in maize, triticale and sorghum, respectively. Better growth performance of FA in combination with organic materials has also been reported (Deepa and Poonkodi 2004; Garg *et al.* 2005; Ram *et al.* 2006; Gupta *et al.* 2007; Ahmad 2017).

The results obtained from present investigation have shown that fly ash in combination with organic manures works as an excellent soil conditioner and helps to a great extent to improve the productivity of the soil through fly ash soil amendment technology (FASAT) on sustainable basis. Nonetheless, new knowledge needs to be generated to further minimize soil and groundwater contamination and identify ways to efficiently exploit the fly ash as a soil ameliorating agent for waste land reclamation and biomass production. Also, Long term investigations should be carried out in different agro-climatic zones to assess the temporal effect of fly ash incorporation on physical, chemical and biological properties of the different soils along with careful monitoring of heavy metals and toxic levels of nutrients.

REFERENCES

Adriano D.C., Page L., Elseewi A.A., Chang A.C. and Strunghan I.R., 1980. Utilization and disposal of fly ash and other coal residues in terrestrial ecosystems: A review. J. Envrion. Qual., **9:** 333-344.

Aggrawal S., Singh G.R. and Yadav B.R., 2009. Utilization of fly ash for crop production: Effect on the growth of wheat and sorghum crops and soil properties. Journal of Agricultural Physics, **9:** 20-23.

Ahmad I., 2017. Utilization of thermal plant wastewater and coal fly ash to improve growth and yield of chickpea (*Cicer arietinum* L.). International Journal of Applied Environmental Sciences, **12(1):** 155-178.

Bilski J., Dissette N., Mclean E. and Soumaila F., 2012. Amelioration of coal fly ash used as cereal crops growth media by Sphagnum peat moss and soil. International Journal of Agri. Sciences, **2(4):** 328-340.

Deepa B. and Poonkodi P., 2004. Effect of lignite fly ash, pressmud and inorganic fertilizers on the growth performance of black gram. Journal of Ecobiology, **16 (2):**147-150.

Garg, R.N., Pathak H., Das D.K. and Tomar R.K., 2005. Use of fly ash and biogas slurry for improving wheat yield and physical properties of soil. Environ. Monit. Assess., **107 (1-3):** 1-9.

Gupta D.K., Rai U.N., Sihna S., Tripathi R.D., Nautiyal B.D., Rai P. and Inouhe M., 2004. Role of Rhizobium (CA-1) inoculation in increasing growth and metal accumulation in *Cicer arietinum* L. growing under fly ash stress condition. Bulletin of Environmental Contamination and Toxicology, **73 (2):** 424-431.

Gupta D.K., Tripathi R.D., Rai U.N., Mishra S., Srivastava S., Dwivedi S. and Maathuis F.J., 2007. Growth and biochemical parameters of *Cicer arietinum* L. grown on amended fly ash. Environ. Monit. Assess., PMID : 17342436.

Jala S. and Goyal D., 2010. ESP fly ash application effects on plant biomass and bioconcentration of micronutrients in nursery seedlings of *Populus deltoids*. Proceedings of 19th World Congress of Soil Science, Soil Solutions for a Changing World, August 1-6 at Brisbane (Australia), pp: 53-56.

Karmakar S., Mittra B.N. and Ghosh B.C., 2009. Influence of Industrial Solid Wastes on Soil-Plant Interactions in Rice under acid lateritic soil. World of Coal Ash (WOCA) Conference, May 4-7 at Lexington, KY (USA), (http://www. flyash.info).

Kruger R.A. and Surridge A.K.J., 2009. Predicting the efficacy of fly ash as a soil ameliorant. World of Coal Ash (WOCA) Conference, May 4-7 at Lexington, KY (USA), (http://www.flyash.info).

Kumar V., Goswami G. and Zacharia K.A., 1998. Fly ash use in Agriculture: Issues and concerns. Proceedings of International Conference on fly ash disposal and utilization. Vol. 1, FAM and CBIP, New Delhi, January 20-22, pp: (vi): 1-7.

Kumar V., Mathur M., Sinha S.S. and Dhatrak S., 2005. Fly ash: An environment savior. Report of Fly Ash Utilization Programme, TIFAC, DST, New Delhi, pp: (iv): 1.1-1.4.

Kumar V., Singh G. and Rai R., 2005. Fly ash: A material for another green revolution. Report of Fly Ash Utilization Programme, TIFAC, DST, New Delhi, pp: (xii): 2.1-2.16.

Mittra B.N., Karmakar S., Swain D.K. and Ghosh B.C., 2003. Fly ash-a potential source of soil amendment and a component of integrated plant nutrient supply system. International Ash Utilization Symposium, Centre for Applied Energy Research, University of Kentucky, (http://www.flyash.info).

Modgal S.C. and Singh C.M., 1990. Crop residue management. In Agronomic Research towards sustainable agriculture (Eds. K.N. Singh and R.P. Singh). Indian Soc. Agron. IARI, New Delhi, pp: 7-23.

Nalawade P.M., Kamble J.R., Late A.M., Solunke K.R. and Mule M.B., 2009. Studies on integrated use of tannery wastewater, municipal solid waste and fly ash amended compost on vegetable growth. International Journal of Agri. Sciences, **1(2):** 55-58.

Patil Y. and Chaudhari G.S., 2004. Impact of water containing coal ash on biochemical contents of *Arachis hypogea*. Journal of Ecobiology, **16 (5):** 397-399.

Prasad B. and Singh A.P., 1980. Changes in soil properties with long-term use of fertilizer, lime and farmyard manure. J. Indian Soc. Soil Sci., **28:** 465-468.

Ram L.C., Srivastava N.K., Tripathi R.C., Jha S.K., Sinha A.K., Singh G. and Manoharan V., 2006. Management of mine spoils for crop productivity with lignite fly ash and biological amendments. J. Environ. Manage., **79 (2) :** 173-187.

Rautaray S.K., Ghosh B.C. and Mittra B.N., 2003. Effect of fly ash organic wastes and chemical fertilizers on yield, nutrient uptake, heavy metal content and residual fertility in a rice-mustard cropping sequence under acid lateritic soils. Bioresour. Technol., **90:** 275-283.

Rethman N.F.G., Reynolds K.A. and Kruger R.A., 1999. Crop responses to SLASH (Mixture of Sewage Sludge, Lime and Fly ash) as influenced by soil texture, acidity and fertility. International Ash Utilization Symposium, Center for Applied Research, University of Kentucky, (http://www. flyash.info).

Sajwan K.S., Harold O.W. and Youngblood T., 1995. The effect of fly ash/sewage sludge mixtures and application rates on biomass production. J. Environ. Sci. Hlth., **30 (6) :** 1327–1337.

Sarkar S., 2006. Effect of Industrial, Municipal and Agricultural wastes on peanut production. The 18th World Congress of Soil Science from July 9-15 at Philadelphia, Pennsylvania (USA), (http://crops.confex.com/crops/wc).

Singh S., Gond D.P., Pal A., Tewary B.K. and Sinha A., 2011. Performance of several crops grown in fly ash amended soil World coal ash (WOCA) conference, May 9-12 at Denver (USA), (http//www.flyash.info).

Sinha S. and Gupta A.K., 2005. Translocation of metals from fly ash amended soil in the plant of *Sesbania cannabina* L. Ritz: Effect on antioxidants. Chemosphere, **61 (8):** 1204- 1214.

Tejasvi A. and Kumar S., 2011. Effect of fly ash extract on seed germination and seedling growth of garden pea. Journal of plant development sciences, **3 (1&2):** 107-111.

Tejasvi A. and Kumar S., 2012. Impact of Fly Ash on Soil Properties. National Academy Science Letters, **35:** 13-16.

Truter W.F., Rethman N.F.G., Reynolds K.A. and Kruger R.A., 2001. The use of a soil ameliorant based on fly ash and sewage sludge. International Ash Utilization Symposium, Center for Applied Research, University of Kentucky, (http://www. flyash.info).

Yeledhalli N.A., Prakash S.S., Ravi M.V. and Narayanarao K., 2008. Long-term effect of fly ash on crop yield and soil properties. Karnataka J. Agric. Sci., **21 (4):** 507-512.

Yunusa I.A.M., Manoharan V., DeSilva D.L., Eamus D., Murray B.R. and Nissanka N.P., 2008. Growth and elemental accumulation by canola on soil amended with coal fly ash. J. Environ. Qual., **37**: 1263-1270.

Yunusa I.A.M., Burchett M.D., Manoharan V., Desilva D.L., Eamus D. and Skilbeck C.G., 2009. Photosynthetic pigment concentrations, gas exchange and vegetative growth for selected monocots and dicots treated with two contrasting coal fly ashes. J. Environ. Qual., **38:** 1466-1472.