International Journal of Current Research in Life Sciences *Available online at http:// /www.wrpjournals.com/journals/V/IJCRLS*
Vol. 3, No.12, pp. 087-090, December 2014

Full Length Research Article

USE OF FLY ASH AS BIO- PESTICIDE FOR COTTON PLANT

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Accepted 27th November, 2014; Published Online 31th December, 2014

Dumping of industrialized solid waste impinge on the soil, thereby inhibiting the crop growth. The key causes of land pollution have been the industries like pulp and paper industries, power industries, iron and steel industries, oil refineries etc. Fly ash, the tarnished waste product of coal based thermal power plants and well-known for its ill effects on agricultural land, may now serve the farming community. Coal and lignite fly ash equally act as a fine carrier for bio pesticides. It is used as a conditioner to detain soil erosion, and to make plant resistance against diseases. Fly-ash is a valuable and handy ameliorant that may perk up the physical, chemical and biological assets of soils and also is a supply of readily accessible plant macro and micronutrients. Supply of nutrients from fly-ash with bio-solids may enhance their, agricultural use. Thus use of fly-ash is an effectual way of utilization of problematical fly-ash waste in a constructive manner. This study was carried out with the aim of studying the beneficial use of fly ash based pesticide for agricultural purpose. The soil was amended with fly ash based bio-pesticide and the crop chosen was cotton. The study evaluated the effect of fly ash on the plant growth and yield of cotton. Fly ash was applied to the soil after mixing it with manure (w/w), in order to study the effect of fly ash on soil properties. For studying the effectiveness of fly ash as pesticide, pesticide dust formulation of fly ash was applied on the cotton leaves. The study undertaken through this paper revealed that fly ash augmented the various pysico-chemical soil properties and effectively can be used as bi-pesticide. It can be successfully employed as a low-priced and economical bio-pesticide by underprivileged farmers. Fly ash based dust formulation increased the cotton productivity. Application of fly ash had detrimental effect on the growth of pesticides, leading to a significant increase in cotton boll weight and cotton yield based on different fly ash application rates.

Key words: Fly Ash, Pest, Pesticide, Cotton, Mealybugs, Boll Weevil

INTRODUCTION

Various devastating ecological and human disasters of the last four decades implicate industries and the waste being generated as a major contribution to environmental degradation and pollution (Lalwani *et al*., 2012). The term 'waste' refers to solid or liquid matter which has no longer any economic value. With industrialization and urbanization, ensuing growth in urban solid and liquid wastes is a relatively recent development in India (Suryawanshi *et al*., 2013). Cotton fits into the genus *Gossypium* and is a soft and fluffy staple fiber, more or less pure cellulose and which nurtures in a shielding capsule, about the seeds of cotton plants. Present world ballpark figures for cotton production are about 110 million bales annually. India is the 2nd largest producer of cotton in the world and takes pleasure in the distinction of being the earliest country in the world to domesticate cotton and use it for fabric manufacturing. India accounts for just about 25 per cent of world's cotton area and 16 per cent of total cotton production. Pesticides are dangerous chemicals as they are manufactured with the aim of killing, resisting or hampering the growth of living organisms by weakening biological progressions crucial for safeguarding of life. In numerous cases, pesticides not only have an effect on the bodily processes of the pest species they are meant to control but also impact upon the well-being of humans and biodiversity. This evident fact is predominantly related with insecticides, accounting for just about 60% of the entire agrochemicals applied to cotton universally. Fly ash is the key solid waste produced in thermal power stations and currently almost 100 million tons of fly ash per year is being generated from 70 the thermal power stations scattered all through the country. Fly ash is very fine glass crushes, the constituent parts of which are by and large sphere-shaped and vary from 0.5 to 100 micron in dimension.

The fine particles of fly ash reach the pulmonary region of the lungs and remain there for long periods of time; they behave like cumulative poisons (Ahmad *et al*., 2012). Disposal of this mammoth magnitude of fly ash is posing an immense difficulty owing to its restricted utilization in the manufacturing of bricks, cements, ceiling and additional civil edifice activities. This would further bring changes in land-use patterns and contribute to land, water and atmospheric degradation, if proper management options for handling ash are not undertaken (Kalra *et al*., 1996).

Making use of fly ash in agriculture offers a practicable alternative for its harmless disposal to perk up the soil environment and augment the crop yield. Nevertheless, a well thought-out management approach has to be developed to decrease the land contamination from the heavy metals present in the fly ash. Present study deals with the effect of the application of varying levels of fly ash based pesticide on early plant growth and yield of cotton.

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MATERIALS AND METHODS

For analysis reason fly ash was collected from Koradi Thermal Power Station, Koradi. In the present study, clayey black soil was mixed with farmyard manure (10% w/w) and amended with fly ash at 5%, 10%, 20% and 40% w/w, in the laboratory and added to selected site. The crop under study was cotton.
Pesticide dust formulation of fly ash was achieved by grinding, filtering, and then blending. The products were then stored in sealed containers and labeled. Pesticide dust formulations were then applied on the cotton leaves making use the laboratory fly ash duster. The leaves were sprayed with water prior to dusting for easy adhering of the dust and then air dried.

RESULTS AND DISCUSSION

The base of each leaf of the cotton plant encloses a small cuplike formation holding nectar in addition to the cotton flowers. These nectar deposits and the luscious stem make the cotton plant attractive to an assortment of insect pests. Most noticeable among these pests is the boll weevil and bollworm. The bollworm-tobacco budworm as well is one of the most detrimental cotton pests in terms of losses and control costs. Other significant pests include armyworm, thrips, lygus and red spider.

Therefore, pest control plays a key role in increasing the production of cotton. At present, pest control is being done by and large through conventional methods. However long-term usage of chemical pesticides can have a prospective harmful impact on the environment, wildlife and human beings. Bio-pesticides control pests by harmless means and are substances available naturally. Usual pesticides however are synthetic materials that either exterminate or inactivate the harmful as well as useful pests.

The proper management of fly ash (FA) generated from coal-burning electrical power plants remains a controversial issue (McNally *et al*., 2012). Physico–chemical analysis of fly ash has revealed the presence of both macro-micro nutrients, which can sustain plant growth. Its application in the agricultural land acts as a liming factor and improves crop growth by neutralizing the soil acidity, increasing the water availability for the plants and supplement of nutrients. The physico-chemical properties of fly ash are given in Table 1.

Application of fly ash to cotton crop indicated that the soil samples have an alkaline pH (8.0) with high calcium and aluminum content (2.44 and 24.17% respectively) and relatively lesser amount of potassium (1.6%). Bulk density was found to be as low as 1.48 g/cm^3 by the addition of fly ash. Short-term field studies had shown dose-based effect of coal fly ash on chemical properties of soil. An increase in pH, electrical conductivity, water holding capacity, calcium and aluminum was observed in the soil with increasing dose and time. Fly ash dose of 20% were found to be most suitable for the soil. An increasing dose of 40% was harmful for the soil nutrients and thus plant nutrient uptake. The presence of calcium, magnesium and iron in most of the fly ash samples was found to improve the quality of cotton crop produced. An increase in arsenic content from 0.002 to 0.008% was also observed. Observations of similar nature were done by other people. They reported that dumping of fly ash in open ash pond causes serious adverse environmental impacts owing to its elevated trace element contents, in particular the arsenic which causes ecological problems (Pandey *et al*., 2011). The changes in various soil parameters by the use of fly ash are listed in Table 2.

Table 1. Analysis of Fly ash

Physical properties	
pH	8.43
Electrical conductivity (MS/cm)	0.155
Bulk density (g/cm$^{3)}$	1.14
Water holding capacity (%)	46
Chemical Properties	
% Organic carbon	0.19
SiO_2 (%)	62.5
Al_2O_3 (%)	17.5
Fe_2O_3 (%)	7.5
CaO (%)	1.75
MgO (%)	1.5
TiO_2 (%)	1.293
P_2O_5 (%)	0.261
K_2O (%)	0.81
Na_2O (%)	0.28
LOI (%)	0.72
Heavy Metals in Fly ash	
Copper (%)	0.55
Zinc (%)	0.64
Manganese (%)	0.4
Boron (%)	0.15
Molybdenum (%)	0.16
Selenium (%)	3.4
Arsenic (%)	1.3
Cobalt (%)	0.08
Chromium (%)	0.45
Lead (%)	0.3
Nickel (%)	1.1
Cadmium (%)	0.05

Table 2. Changes in properties of soil on addition of Fly Ash

Physical properties	Initial value	Changed value
pH	7.6	8
Electrical conductivity (dS/m)	0.28	0.32
Natural moisture content (%)	45	43
Bulk density (g/cm^3)	1.56	1.48
Water holding capacity (%)	63.5	65
Chemical properties		
% Organic carbon	0.62	0.6
SiO_2 (%)	63.1	64
Al_2O_3 (%)	24.07	24.18
Fe_2O_3 (%)	3.5	3.9
CaO (%)	2.39	2.43
MgO (%)	1.55	1.58
MnO_4 (%)	2.05	2.06
TiO_2 (%)	0.04	0.05
P_2O_5 (%)	0.08	0.1
K_2O (%)	1.6	1.75
NO_3N (%)	0.05	0.045
Na_2O (%)	0.38	0.37
As_2O_3 (%)	0.002	0.008
CuO (%)	0.01	0.013
ZnO (%)	0.014	0.018
ESP	5	3

Making use of fly ash as pesticide is well acknowledged. Despite the fact that limited quantity could be utilized for this purpose, the fly ash based dust pesticide formulation prepared is cost effective (Vitekari *et al*., 2012). Cotton plants under study are infected by various different types of pests, some of which are exceeding damaging. Few of these cotton pests are boll weevil and boll worm, which causes reduction in lint development and makes way for rot organisms into the

Table 3. Pests affecting the cotton plant under study

Sr No.	Pest	Effect on Cotton Plants
1	Boll weevil and Boll worm	Reduces Cotton lint development and makes way for rot organisms
2	Cotton aphids	Curls and puckers the leaves. Causes shedding of young fruiting forms and premature opening of infested flowers and bolls
3	Cotton thrips	Attack seedling cotton. Makes infested foliage distorted and curled upward. Sometimes kills terminal buds
4	Green stinkbug	Damage immature bolls by piercing fruit wall. Feeds on immature seeds
5	Serpentine leaf miner	Causes drying and dropping of leaf due to severe infestation
6	Mealybugs	Attacks growing parts viz., the main stem, branches, fruit and immature Flowers

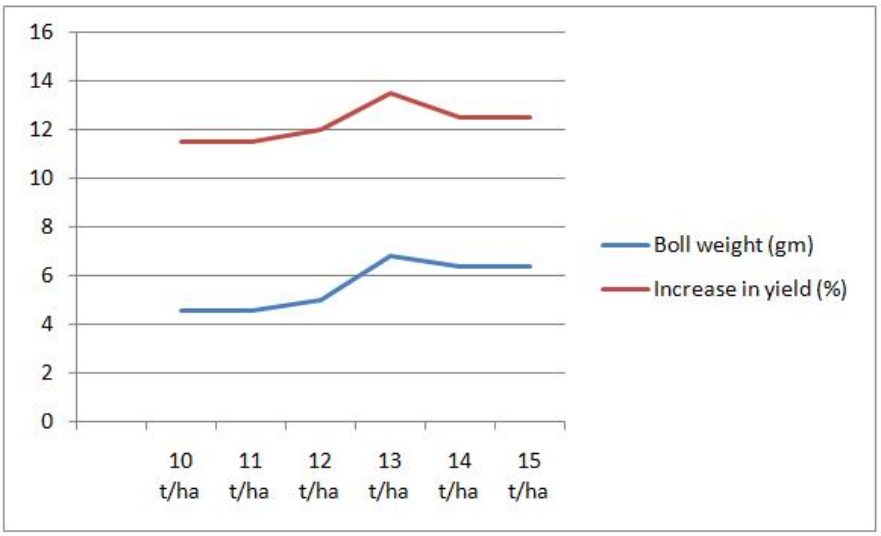

Figure 1. Graphical representation of Increase in Boll weight and Cotton yield based on different fly ash application rates

partially damaged bolls and cotton aphids which curls and pucker the leaves and makes heavily infested seedlings stunted leading to their death was controlled to some extent by the use of fly ash. Several species of thrips which attack seedling cotton and makes the infested foliage distorted and curled upward, sometimes killing terminal buds were reduced by the use of fly ash based bio-pesticide. A few cotton pests which were not recognized previously have emerged as major pests. Two emerging pests of in South-Central India, the Green stinkbug which damages immature bolls by stabbing the fruit wall and feeding on immature seeds and Serpentine leaf miner which causes drying and subsequent dropping of leaves due to severe infestation were kept under check by use of fly ash as pesticide.

Species of mealybug, also an emerging pest attacks the growing parts of cotton namely, the core stem, branches, fruit and immature flowers thereby adversely resulting in yield reduction. Using fly ash as bio-pesticide aided in the control of these mealybugs also to some extent. Table 3 lists the various pests affecting cotton under study. Additionally, farmers reported that in the absence of soil borne pests, the size of cotton buds and their luster got improve with the application of fly ash, resulting in better quality marketing. Fly ash based dust formulation increased the cotton productivity on an average by 12.25%, leading to a profit of about Rs 5000/ha. In addition to the yield of produce, significant increase in biomass yield was also found. Figure 1 shows the change in cotton bud size and cotton yield on use of fly ash. Fly ash application rate of 13 t/ha was found to give the maximum yield. Figure 1 gives the graphical representation of increase in boll weight and cotton yield based on different fly ash application rates.

Conclusion

Industrial waste like fly ash is an important waste resource, having a potential of recycling in agricultural land. Fly ash is a waste product residue resulting from the combustion of pulverized coal in coal-fired power generating station. Even though fly ash cannot entirely accomplish the need of chemical fertilizers or organic manure it can be used in combination with these for improvement of organic, physical and elemental properties of soil. Use of fly ash thus augmented the various soil properties. Fly ash based bio pesticides are valuable in controlling an assortment of insect pests autonomously. These less expensive bio-pesticides can be used effectively by the bottom level farmers. Thus, utilization of fly-ash as carrier in bio-fertilizer formulations emerged as safe and effective alternatives. Use of fly-ash as carrier in these formulations is an effective way of utilization of problematic fly-ash waste in a useful manner (Kumar *et al*., 2010).

Acknowledgement

The authors are thankful to various cotton research scientists for their support and help. They are also thankful to the cotton farmers for giving their valuable feedback on use of fly ash.

REFERENCES

Ahmad, S., Fulekar, M.H. and Pathak, B. 2012. Impact of Coal Based Thermal Power Plant on Environment and its Mitigation Measure. *International Research Journal of Environment Sciences*, 1(4), 60-64.

Kalra, N., Joshi, H.C., Sharma, S.K., Harit, R.C. and Brij Kishor, 1996. Effect of fly ash incorporation on soil and crop productivity, ICAR News, 2(2), 18.

Kumar, V., Chandra, A. and Singh, G. Efficacy of fly-ash based bio-fertilizers vs perfected chemical fertilizers in wheat (Triticum aestivum), *International Journal of Engineering Science and Technology*, 7(2), 31-35(2010)

Ladwani, K. D., K. D., Ladwani, V. S., Manik and D. S. Ramteke, 2012. Impact of Industrial Effluent Discharge on Physico-Chemical Characteristics of Agricultural Soil. *International Research Journal of Environment Sciences*, 1(3), 32-36.

McNally, D., Crowley-Parmentier, J. and Whitman, B. 2012. Trace Metal Leaching and Bioavailability of Coal-Generated Fly Ash. *International Research Journal of Environment Sciences*, 1(5), 76-80.

Pandey, V.C., Singh, J.S., Singh, R.P., Singh, N. and Yunus, M. 2011. Arsenic hazards in coal fly ash and its fate in Indian scenario. *Resource Conservation and Recycling*, 55(9), 819-835.

Suryawanshi, P.C., Jain, K.A., Bhardwaj, S., Chaudhari, A.B. and Yeole, T.Y 2013. Solid and Liquid Wastes: Avenues of Collection and Disposal. *International Research Journal of Environment Sciences*, 2(3), 74-77.

Vitekari, H. N., Talele, A. P., Mane, R. G., Gaikwad, V.S. and Shah, J.V. 2012. Fly ash based biopesticides: A comprehensive review, *Biological Sciences*, 59, 173-178.

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