Environment & Ecology 35 (1B) : 506—509, January—March 2017
Website: environmentandecology.com ISSN 0970-0420

Seed Invigouration Through Fly Ash Pelleting Improved Crop Growth and Productivity of Cowpea (*Vigna unguiculata* L.)

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Received 11 May 2016 ; Accepted 13 June 2016 ; Published online 30 June 2016

Abstract Pelleting is a presowing physical seed management technique, in which growth promotive substances with protective, nutritive and invigourative function are applied on the seed to enhance the seed-soil relationship. Fly ash is generated during the combustion of coal in coal fired thermal power plants and paper industry where coal is used as the raw material. Fly ash is not a waste material, it is an available mineral asset waiting to be recognized as such and turned into a useful resource. Hence studies were initiated on pelleting of seeds of cowpea cv CO_1 after soaking separately in different enhancement treatments viz., thiram @ 2g/kg of seed, halogen mixture @ 3g/kg of seed, arappu leaf powder @ 200 g/kg of seed, pungam leaf powder @ 200 g/kg of seed, carbendazim @ 2g/kg of seed, 3% vipul, 3% planofix, 3% cytozyme, 3% multizyme and were pelleted with fly ash @ 250 g per kg of seed. The pelleted seeds were rolled on a flat and smooth surface for 30 minutes for shaping. The pelleted seed along with control were evaluated for productivity. In addition, to study the influence of treatments on the physiological parameters, measurements were made on leaf photosynthetic rate, transpiration rate, stomatal conductance and intercellular CO_2. The results revealed that seed treated with halogen mixture @ 3g + fly ash @ 250 g per kg of seed was optimum for improving productivity of seed. The cause for improvement was found to be the increased photosynthetic rate and stomatal conductance.

Keywords Fly ash, Cowpea, Seed pelleting, Enhancement, Seed yield.

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Introduction

Fly ash has various mineral materials and can be beneficially utilized for increasing agricultural production. Approximately, on average 95 to 99% of fly ash consists of oxides of silica, aluminium, iron and calcium and about 0.5 to 3.5% of the sodium, potash and single super phosfate with the remaining ash being trace elements [1]. The average size of fly ash is <10 µm diameter with low to medium bulk density, high surface area and very light texture. Agriculture is one of the beneficial outlets for utilization of fly ash . Fly ash treated *Festuca arundinaceae* showed better growth on acidic, mine soils, thus demonstrating the utility of fly ash in agriculture.

Seed is the carrier of technologies and innovations. Seed pelleting is the most applicable technique in direct sown crops which need an initial vigor boost for sustained crop growth and development. Pelleting provides an opportunity to pack effective quantities

of materials such that they can influence the micro environment of each seed which supplies not only micro and macro nutrients but also protects the crop from pests and diseases in the earlier stages on inclusion of pesticides. Fly ash pelleted seed was found to improve the seed and seedling quality characters in silvicultural species [2]. Blackgram reported that fly ash pelleting @ 200 g per kg of seed improved seed yield [3]. Cowpea (*Vigna unguiculata* (L.) Walp) belongs to the family Fabaceae is known as labia and vegetable meat. It is used as a pulse, vegetable, fodder and green manure crop. Hence, studies were initiated with cowpea to determine the effect of different doses of fly ash as pelleting material on productivity.

Materials and Methods

Freshly harvested seeds of cowpea cv CO 1 obtained from Tamil Nadu Agricultural University, Coimbatore were graded for uniformity and soaked separately in different enhancement treatments viz., T_0–Control, T_1–Thiram @ 2g / kg of seed, T_2–Halogen Mixture @ 3g / kg of seed, T_3–Arappu Leaf Powder @ 200 g/kg of seed, T_4–Pungam Leaf Powder @ 200 g / kg of seed, T_5–Carbendizm @ 2g / kg of seed, T_6–3% Vipul, T_7–3% Planofix, T_8–3% Cytozyme, T_9–3% Multizyme and were pelleted with fly ash @ 250 g per kg of seed per treatment and were rolled on a flat and smooth surface for 30 minutes to shape the pellets. The pelleted seeds were evaluated for productivity at Department of Genetics and Plant Breeding, Faculty of Agriculture, Annamalai University, Annamalai Nagar, (11.24° N latitude, 79.44° E longitude, + 5.79 m altitude, above mean sea level) in plot size of 3 × 3 m using a Randomized Block Design in three replications. The seeds were sown at the spacing of 30 × 15 cm with basal NPK application of 25 : 50 : 0 kg per ha. The other cultural practices were adopted as per the guidelines of Tamil Nadu Crop Production Guide, published by the Department of Agriculture, Tamil Nadu. At harvest, 10 plants were selected at random for observations on plant height, number of branches per plant, number of leaves per plant, leaf area (using portable leaf area meter am 300), dry matter production, number of clusters per plant, number of seeds per pod and seed yield per plant.

During 50% flowering phase, ten plants in each of the treatment were identified and the gas exchange parameters of leaf photosynthetic rate, transpiration rate, stomatal conductance and intercellular CO_2 concentration were measured using LICOR – 6400 × T portable photosynthetic system (Lincoln, USA). The data collected were statistically analyzed for determining the significance at 0.05% [4]. The percentage values were converted to arcsine values, while non significant results were indicated as NS.

Results and Discussion

Highly significant results were obtained for growth and yield characteristics (Table 1). The maximum plant height was observed in the seeds treated with halogen mixture @ 3g + fly ash @ 250 g per kg of seed (58.98 cm) and was followed by pungam leaf powder @ 200 g + fly ash 250 g per kg of seed (56.31 cm). The minimum plant height was noted in control plots (44.02 cm) when compared to all other treatments. The seeds treated with halogen mixture @ 3g + fly ash @ 250 g per kg of seed recorded the maximum number of branches (9.89), leaves (23.82), leaf area (1670.39 sq cm), dry matter production (32.24 g $plant^{-1}$), number of clusters per plant (8.09), number of seeds per pod (18.89) and seed yield per plant (14.78 g). The next best treatment was found to be seed treated with pungam leaf powder @ 200 g + 250 g fly ash per kg of seed. The minimum values for all the growth attributes were recorded in control seed.

The presence of various micronutrients in fly ash which could be utilized as fertilizer for agricultural crops [5]. The influence of fly ash pelleting on improved productivity in blackgram and bhendi [6]. Soybean seeds pelleted with vermicompost + arappu + thiram using 10% maida as an adhesive enhanced to significantly increased field establishment and seed yield [7]. The increase in yield was attributed to alleviation of toxicities associated with low soil pH negatively affecting molybdenum uptake. The significant differences exist between the pelleted and non pelleted seeds in terms of the height of the plants (cm), number of altered branches per plant and number of capsules per plant in sesame [8]. The fly ash pelleting @ 200 g per kg of seed improved seed yield

Table 1. Influence of seed enhancement treatments on growth and yield parameters of cowpea cv CO 1.

Treatments	Plant height (cm)	No. of branches	No. of leaves	Leaf area (sq cm)	Dry matter production (g plant^{-1})	No. of clusters / plant	No. of seeds / pod	Seed yield/ plant (g)
T_0	44.02	5.01	17.07	1166.81	26.70	4.27	14.29	10.39
T_1	53.79	8.78	20.29	1509.43	30.42	6.89	17.21	13.40
T_2	58.98	9.89	23.82	1670.39	32.24	8.09	18.89	14.78
T_3	55.12	8.92	21.07	1571.01	30.98	7.43	17.93	13.77
T_4	56.31	9.07	22.38	1648.09	31.33	7.98	18.03	13.95
T_5	52.07	7.61	19.29	1446.29	29.78	6.71	16.79	13.27
T_6	49.87	7.29	18.98	1363.44	29.27	6.40	16.47	13.00
T_7	48.28	6.48	18.42	1306.48	28.23	5.35	16.31	12.81
T_8	46.38	6.03	18.03	1296.00	27.68	5.07	15.27	12.17
T_9	45.74	5.34	17.96	1206.97	27.42	4.81	14.97	11.09
SEd	0.68	0.22	0.32	25.02	0.25	0.17	0.20	0.30
CD (p = 0.05)	1.38	0.45	0.64	48.56	0.51	0.35	0.41	0.62

in blackgram [3]. Fly ash as an amendment in agricultural soils can improve the physical and chemical properties of soils, thereby improving soil fertility and crop yield. Non–judicious use, however, may lead to problems in terms of deterioration of soil texture and structure mainly in the upper soil layer, surface crust formation, impeding the water intake capacity of the soil, addition of toxic elements and alteration in physico-chemical, in this fact pelleting which carry minimum amount on seed would be an effective alternative to usage on seed.

Table 2. Influence of seed enhancement treatments on gas exchange parameters in cowpea cv CO 1.

Treatments	Leaf photosynthetic rate mg CO_2 $m^{-2}s^{-1}$)	Transpiration rate (mg H_2O $m^{-2}s^{-1}$)	Intercellular CO_2 (µ mol mol^{-1})	Stomatal conductance (mol $m^{-2}s^{-1}$)
T_0	13.84	7.837	286.7	0.483
T_1	16.92	8.986	297.1	0.661
T_2	17.26	9.553	320.3	0.693
T_3	17.03	9.150	302.1	0.677
T_4	17.15	9.366	315.2	0.680
T_5	16.45	8.835	293.7	0.622
T_6	16.13	8.765	290.2	0.585
T_7	15.72	8.432	288.3	0.541
T_8	15.43	8.148	287.5	0.521
T_9	14.98	7.940	287.0	0.493
SEd	0.16	0.08	1.60	0.01
CD (p = 0.05)	0.38	0.17	3.21	0.02

The measurements on leaf photosynthetic rate, transpiration rate, stomatal conductance and intercellular CO_2 (Table 2) made to help determine the cause for improved efficacy of pelleted seed, also revealed that seed treated with Halogen Mixture @ 3g + fly ash @ 250 g per kg of seed recorded higher values indicating the translocation of nutrients from source to sink that were applied to the root zone through pelleting. The minimum leaf photosynthetic rate, transpiration rate, stomatal conductance and intercellular CO_2 were measured in the control, while all other pelleting treatments were found to have higher rates of gas exchange parameters and among them, Halogen Mixture @ 3g + fly ash @ 250 g per kg of seed had the most improved productivity. The efficacy of hardening and pelleting also expressed these physiological parameters coincided with the efficacy of treatment effect on productivity [9].

Conclusion

The addition of fly ash added nutrients and minerals to the rhizosphere region of the plant, which might be the cause(s) for yield improvement seen in the resultant seedlings. Seed treated with Halogen Mixture @ 3g + fly ash @ 250 g per kg of seed was been found to be most beneficial and might have served as the opti-

mum dose for improving the nutrient content of the rhizosphere region of pelleted seed.

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