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Research Article

UTILIZATION OF INCINERATION ASHES BY SUGAR FACTORIES & DISTILLERIES FOR PRODUCTION OF VALUABLE BIO FERTILIZERS AND THEIR EFFECT ON URAD CROP

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Abstract: Boiler ash, a byproduct resulting from the combustion of the bagasse generated in the sugar plants and potash rich ash obtained after burning slope (Concentrated Spent wash) with bagasse, is recognized as a toxic solid waste throughout the world. This solid waste, which is produced in behemoth volume, has very limited applications and directly disposed to landfills. Therefore, these ashes instead of land filling were used as carrier for production of bio-fertlizers and can generate further revenue for sugar industry. So Attempts were made to assess the screening and characterization of isolates from root nodules (Rhizobium) and soil (Phosphate solubilizing Bacteria) with multiple beneficial properties like nitrogen fixation, mineral phosphate solubilization and production of Plant Growth Promoting substances. These prepared bio-fertilizers were applied in field trials on selected urad crop, which was conducted at farm of NSI Kanpur for two years. The field trials on urad crop were done using 8 different treatments. The data were recorded on various growth and yield attributing parameters. Significantly lower grain yield and number of effective nodules were obtained with T1 where no fertilizer and biofertilizers were applied. Based on the mean performance of two years the T5 (100% RDF + Rhizobium+ PSB) of K rich ash was found as best treatment for plant growth and seed yield. This obtained high in plant height, pods weight per plant, grain weight and Straw weight (kg/ha-1) and was significantly superior over Control. Treatment T3 (100% RDF + PSB), and T4 (100% RDF + Rhizobium) were found effective in respect of recorded higher values of these plant growth characters than rest of the treatments in both the different carrier based biofertilizers. Treatments T6, T7 and T8 bio-fertilizers without RDF also showed significant performance than control. Interaction effect of bio-fertilizers was significant for all characters. Thus, it indicates that the process of bio-fertilizers may be good option for seed growers to achieve seed yield and yield components in urad with potash rich ash as a carrier for biofertilizers.

Keywords: *Potash rich ash, Boiler ash, Bio-fertlizer, Rhizobium, PSB and Urad*

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Introduction

The present study illustrates the effects of bio-fertilizers on plant growth and yield characters of Urad. These bio-fertilizers were prepared by the solid wastes left behind in sugar and distillery industries after the production of sugar and ethanol that is boiler ash and potash rich ash which can be used as a suitable carrier for inoculants. These solid wastes create environmental issues and breathing problems to the labourers. Therefore, these ashes instead of land filling were used as carrier for production of bio-fertilizers and can generate further revenue for sugar industry. Attempts were made to assess the screening and characterization of isolates from soil and root nodules with multiple beneficial properties like nitrogen fixation, mineral phosphate solubilization and production of Plant Growth Promoting substances. On the other hand the increase in the world's population has intensified the agricultural production with the extensive use of fertilizer, improved seeds, irrigation water and pesticide. The increased crop productivity over the years has put multifold pressure on soil resources causing removal of plant nutrients from soil. The recharge of nutrient lost by crop removal through the use of chemical inputs has been found to slow down the biological activities in the soil causing reduced soil health. At this juncture it becomes imperative to use alternative technologies that have no harmful effects on the environment and have the potential of enhancing crop production on a sustainable basis. The soil is a living system, it contains millions of different types of creatures. These creatures are very important for recycling nutrients. Feeding the soil with manure or compost feeds the whole variety of life in the soil which then turns this material into food for plant growth. This also adds nutrients and organic matter to the soil Klopper *et al*., 1988 [1]. Bio-fertilizers are defined as preparations containing living cells or latent cells of efficient strains of microorganisms that help crop plants to uptake nutrients by their interactions in the rhizosphere when applied through seed or soil. They accelerate certain microbial processes in the soil which augment the extent of availability of nutrients in a form easily assimilated by plants [2-4]. Use of bio-fertilizers is one of the important constituents of integrated nutrient management, as they are cost effective and renewable source of plant nutrients to supplement the chemical fertilizers for sustainable agriculture. Several microorganisms and their association with crop plants are being exploited in the production of bio-fertilizers.

Bio-fertilizers are usually applied in plant system as carrier-based inoculants containing effective microorganisms. Incorporation of microorganisms in carrier material enables easy-handling, long-term storage and high effectiveness of bio-fertilizers Damir *et al*., [2011] [5]. A carrier should be non toxic with good pH buffering capacity. In the present study efforts have been made to explore a novel strategy for utilizing these solid wastes for the development of Rhizobium and PSB (Phosphate solubilizing bacteria) bio-fertilizers and thus reducing the burden on landfills.

Materials and Methods

The present study was carried out at National Sugar Institute, Kanpur. Pure cultures of Plant Growth Promoting Rhizobium and Pseudomonas were isolated from different sources.

Attempts were made to assess the screening and characterization of isolates with multiple beneficial properties like nitrogen fixation, mineral phosphate solubilization and production of Plant Growth Promoting substances on selected crop.

Production of Bio-Fertilizers

Ashes were procured from sugar and distillery Plant. The ash from sugar was baggase based which is obtained from boiler and the potash rich ash is obtained from distillery when slop from spent wash were burn along with bagasse in 70:30 ratio. Sterilization of carrier material is important to keep high number of inoculant bacteria on carrier for longer time. Carrier material is packed and autoclaved for 60 min at 121°C. Mass Multiplication of the selected isolates were multiplied in large quantities in appropriate culture broth by incubating at 28±2°C in an incubator shaker till they attained log phase with a cell load of 1×109 cfu ml^{-1} and were used for inoculant preparation. The individual carrier pH was checked and the sterilized carrier allowed to cool and then mixed with the log phase culture 1×109 cfu ml^{-1} of the selected plant growth promoting bacterial isolates *viz*., Rhizobium and Pseudomonas, individually in separate quantities of sterile carrier in shallow trays. The optimum moisture content was adjusted to (30-40%) prior to preparation and then packed in polythene bags following aseptic conditions. Shelf life at studied at the incubation period 20, 40 and 60 days. At each incubation period cell density was assessed by the serial dilution method by diluting samples up to 10-7. The samples were then plated on N free Jensen's agar medium for further growth and incubated at 28°C for 48-72 hrs.

Field Experiment

A field experiments were taken up consecutively for two years to assess the effect of Bio-fertilizers using two different carriers' one boiler ash and other potash rich ash. The experiment was performed in two sets on the crop of Urad.

Experimental Site

These field experiments were conducted at agriculture farm, National Sugar Institute, Kanpur during 2019 March-May and 2020 March -may

Experimental Details:

The experiments were carried out with following details given below.
Experiment design-Randomized Design (RBD)
Total no of treatments-8
Total no. of plots-24
Plot size-25 m^2
Crop- Urad.

Experimental design and layout

These experiments were laid out in a randomized block design with 3 replications. The details of the experiment design and layout are given in [Table-1].

Table-1 *Experimental Layout Design and Different Bio-Fertilizer Combination Treatments.*

Treatments	Details of treatments nutrients $Kgha^{-1}$
T_1	Control
T_2	RDF 100% (20:60:40)
T_3	RDF 100% + PSB
T_4	RDF 100% + Rhizobium
T_5	RDF 100% + PSB + Rhizobium
T_6	Rhizobium @ 2 kg/ha
T_7	PSB @ 2 kg/ha
T_8	Rhizobium + PSB

Fertilizer Application: The fertilizer was applied at the time of sowing. The recommended dose of nitrogen, phosphorus and potash were applied in all the plots except control.

After care: To maintain the uniform plant population, thinning and gap filling were done after 12 days of sowing. To control the weeds in the plots two hand weeding were done first after 20 days and second after 40 days of sowing. It was observed that the crop was infested by the blister beetle during the flowering stage and was controlled by the application of Endosulfon.

Harvesting and threshing: After the crop has attained proper maturity. The crop was harvested at ground level by cutting with hand sickle and the harvested plant of each plot was labeled and bundled and sun dried separately, threshed and cleaned manually.

Plant sampling and observation Growth parameter: For recording the vegetative character, five randomly selected plants are tagged in each plot and their growth observation was recorded at Harvest.

Plant height (cm): The height of the plant was measured by the linear scale from the ground level up to the tips of the plant at Harvest. The average plant height was calculated for each treatment.

Yield attributes: After proper maturity of crops, five plants were randomly, selected and averaged data was worked out for pods weight per plants: The pods of 5 plants were counted and their average was estimated.

Number of seed per pod: From the selected samples, the number of seeds per pod were counted and average were obtained 1000 grain weight or test weight (g): From the individual plot the threshed grain samples were taken randomly for test weight 1000 seed were counted and weight to get the test weight of grains.

Grain yield (Kg/ha): The harvested plants from net area of each plot were threshed separately. The weights of the Straw per plot were recorded separately.

Chemical analysis of plant materials: The Black gram grains and straw samples were washed with demonized water and dried in sun followed by oven dry at 70°C and powdered and packed in polythene bags with proper labeling for chemical analysis.

Nitrogen: Nitrogen in plant and grain sample was analysed by Kjeldhal method. Potassium by Flame photometer and phosphorus by Olsen method

Statistical analysis: The data recorded during the course of this experiment were statistically analysed by following "Randomized Block Design" as described by Panse and Sukhatme (1985). Significance or non-significance of variance due to treatment was determined by calculating respective "F" values. The standard error of differences (S.Ed ±) was calculated by using the following expression. The significance was tested by calculating the critical difference (CD) at 5% level of significance wherever, "F" test was found significant the critical difference (CD) was calculated to find out the significance or non-significance of mean differences among treatments by using the following formula

SE(±)= [√2X Error Mean square] / Replication

CD = S.Ed. × "t" (Fisher)

Where, t= Tabulated value of "t" at 5 per cent probability level of error degree of freedom (D.F)

Results and discussion

The application of bio-fertilizers for important crops like leguminous crops, oilseeds, rice, millets and others besides forest nursery plants are very common in India. India needs to produce 230- 240 million tonnes of food grains to feed the geometrically growing population. Green revolution and application of modern agro-technologies boosted our nation to become self sufficient in its food grain requirements and resulted in impressive savings in land use (Borlaug and Dowswell, 1994) [6]. Among bio-fertilizers, Rhizobium is recommended for grain legumes to improve productivity and augment the soil nitrogen status. A "good" strain of Rhizobium is capable of forming effective nitrogen fixing nodules in the legumes. These rhizobia should be superior in their ability to survive in the soil and should have the ability to fix nitrogen symbiotically under diverse agro-climatic conditions [7]. Nitrogen and phosphorus are most important plant nutrient for crop production. Nitrogen constituent of chlorophyll, harnesses solar energy and fixes atmospheric CO_2 as carbohydrates. Phosphorus plays important role in root development, nodulation, flowering, fruiting and is usually a constituent of phospholipids, nucleic acid, protein, coenzyme, NAD, NADP, and ATP. So, Rhizobium and PSB biofertilizer were prepared.

Urad plays an important role in Indian diet, as it has higher protein uptake. It can be successfully raised in the field where adequate irrigation facilities are available. Being leguminous crop, nitrogen is required in initial stage for good start of crop growth and development. Phosphorus is the key element for vigour of plant, yield and quality. It stimulates the symbiotic nitrogen fixation and enhances the rate of protein synthesis in pulse crop.

Table-2 *Effect of different treatments on plant height, pod weight/plant and grain weight /plant when Potash rich ash was used as carrier for bio-fertilizer production*

Treatment	Plant height		Pod weight/plant		Grain weight /plant	
	2019	2020	2019	2020	2019	2020
T_1-Control	30.8	31.0	6.3	6.7	3.7	4.0
T_2-RDF (100%) (20:60:40)	41.0	41.5	8.0	8.4	5.4	5.6
T_3-RDF(100%) + PSB	43.0	43.2	8.1	8.4	5.3	5.6
T_4-RDF(100%) + Rhizobium	43.80	44.2	8.2	8.6	7.5	7.8
T_5-RDF(100%) + PSB + Rhizobium	46.0	46.0	8.3	8.8	7.6	8.0
T_6- Rhizobium	36.50	37.0	7.1	7.5	6.5	6.7
T_7- PSB	37.0	37.8	7.2	7.5	6.7	6.8
T_8- Rhizobium+ PSB	37.80	37.8	7.4	8.6	7.9	8.2
S.E.	5.82	4.80	0.89	1.02	1.47	1.52
CD (5 %)	11.98	9.88	1.83	2.10	3.03	3.13

Table-3 *Effect of different treatments on grain straw yield (kg/ha) and Test weight (1000 seed) when Potash rich ash was used as carrier for bio-fertilizer production*

Treatment	Grain Yield (Kg/ha)		Straw yield (kg/ha)		Test weight (gm)	
	2019	2020	2019	2020	2019	2020
T_1-Control	790	830	1410	1520	40.0	39.8
T_2-RDF(100%) (20:60:40)	1002	1050	1940	2050	40.3	40.3
T_3-RDF(100%) + PSB	1050	1084	1880	2070	40.3	40.35
T_4-RDF(100%) + Rhizobium	1048	1090	1910	2080	40.3	40.3
T_5-RDF(100%) + PSB + Rhizobium	1098	1250	1950	2110	40.5	40.48
T_6- Rhizobium	830	890	1610	1760	40.1	40.0
T_7- PSB	850	920	1650	1850	40.1	40.1
T_8- Rhizobium+ PSB	890	970	1700	1910	40.3	40.3
S.E.	36.20	40.28	48.2	38.90	0.85	0.71
CD (5 %)	80.70	82.97	99.29	80.13	NS	NS

Table-4 *Effect of different treatments on N, P, and K update when potash rich ash was used as carrier for bio-fertilizer production*

Treatment	N Update (kg/ha)		P Update (kg/ha)		K Update (kg/ha)	
	2019	2020	2019	2020	2019	2020
T_1-Control	70.40	71.00	6.32	7.02	44.20	46.20
T_2-RDF(100%) (20:60:40)	94.10	97.50	8.50	8.90	56.00	59.20
T_3-RDF(100%) + PSB	97.80	101.20	8.95	9.20	59.10	60..76
T_4-RDF(100%) + Rhizobium	98.50	102.80	8.82	9.36	58.90	61.20
T_5-RDF(100%) + PSB + Rhizobium	105.80	116.20	9.35	10.76	62.10	70.20
T_6- Rhizobium	72.10	81.00	7.15	7.50	46.48	49.80
T_7- PSB	75.00	82.70	7.28	7.90	48.10	52.20
T_8- Rhizobium+ PSB	80.70	89.50	7.60	8.30	50.10	54.90
S.E.	10.12	9.82	2.07	2.40	8.25	8.90
CD (5 %)	20.84	20.22	4.28	4.94	16.99	18.33

The farmers followed the inappropriate methods in cultivation by applying the excess amount of fertilizers, which are not suitable for crop growth. In order to find out the suitable fertilizers for integrated management system of sustainable agriculture, an attempt has been made to explore the effect of various organic manures, inorganic fertilizers and biofertilizers on germination, growth and yield of black gram (*Vigna mungo* (L.)

The experimental findings based on the observation recorded during the course of investigation has been critically examined and statistically analyzed. Records of various field observations as well as those of laboratory analysis are presented in tables. The tables of analysis of variance are given in appendix section.

Effect of Bio-fertilizer using Potash rich ash and boiler ash from distillery as Carrier on urad

Based on two years data using Potash rich ash as Carrier mean performance for plant height (cm) ranged from 30.9 to 46 with mean value of 39.6. T5 with application of 100% RDF + Rhizobium and PSB were recorded highest plant height (cm) (46). T4 (44) was at par with T5 with application of 100% RDF + rhizobium followed by T3 (43.1), T2 (41.25) T8 (37.8), T6 &7 (37), and T1 (30.9) with control [Table-2]. In case of Boiler ash as carrier

Again based on two years data mean performance for pod weight (gm/plant) ranged from 6.5 to 8.5 with mean value of 7.8. T5 with application of 100% RDF + Rhizobium and PSB recorded high pod weight (8.5). T 2, 3, & 4 were at par with T5 (8.5) with application of RDF alone, RDF+ Rhizobium, RDF +PSB+ Rhizobium respectively followed by T8 (8), T6 ,T7(7.3) and T1 (6.5) recorded less pod weight [Table-2].

Consequently, based on two years data mean performance from grain weight (gm/plant) ranged from 3.8 to 8.05 with mean value of 6.4. T5 & T8 with application of 100% RDF + Rhizobium+ PSB and Rhizobium+ PSB recorded high grain weight (7.8 & 8.0). T5 was at par with T4 (7.65) with application of application of RDF alone followed by T7 (6.7), T6 (6.6), T2 (5.5), T3 (5.4) and T1 (3.8) with control recorded less value of grain weight [Table-2].

Grain yield: Significant increase in yield and yield attributes of Urad responded positively with the application of bio-fertilizers + RDF, may be due to complementary effect of bio-fertilizers on chemical fertilizers [8]. Effect of different treatments on grain and straw yield are presented in [Table-3]. Grain yield recorded under different treatments varied from 810 to 1174 Kgha^{-1}. The higher grain yield 1174 Kg ha^{-1} was recorded in T5 with application of 100% RDF + Rhizobium and PSB, while lowest grain yield 810 kgha^{-1} was found in T1 (control). Treatment T4 &T3, were at par but also significantly higher than control T2. T8 were found significantly higher than remaining treatment. Treatment T6 &T7 having rhizobium and PSB alone without RDF was also higher than control but Non-significant.

Straw yield: Straw yield under various treatment combinations showed a significant difference. Straw yield varied from 2030 to 1465 kg ha^{-1} under different treatments [Table-3]. The highest straw yield 2030 kgha^{-1} was found in T5 while lowest 1465 kgha^{-1} in T1 (control). Straw yield obtained in T5 was found statistically at par to the straw yield found in T3, T4 and T2 were significantly higher than the remaining treatments. Significantly lower straw yield (1465 kg ha^{-1}) than the other treatments was found in T1.

In case of Boiler ash when used as carrier we got similar type of trend in Plant height, Pod weight, grain weight, grain yield and straw weight. Treatment where biofertilizer were applied with inorganic fertilizer yielded significantly higher straw yield over T2 (recommended dose of NPK). Similarly, application of bio-fertilizer alone resulted in significantly higher yield traits over T1 (Control).

Table-5 *Effect of different treatments on plant height, pod weight/plant and grain weight /plant when boiler ash was used as carrier for bio-fertilizer production.*

Treatment	Plant height (cm-1)		Pod weight/plant		Grain weight /plant)	
	2019	2020	2019	2020	2019	2020
T_1-Control	31.0	30.0	7.0	6.8	3.80	4.0
T_2-RDF(100%) (20:60:40)	41.8	40.2	8.5	7.9	5.60	5.5
T_3-RDF(100%) + PSB	42.5	41.0	8.6	8.2	5.68	5.6
T_4-RDF(100%) + Rhizobium	43.0	41.8	8.55	8.1	5.68	6.0
T_5-RDF(100%) + PSB + Rhizobium	45.60	43.2	8.70	8.2	5.72	6.5
T_6- Rhizobium	36.8	35.0	7.50	7.1	4.0	5.0
T_7- PSB	36.8	35.7	7.50	7.1	4.10	5.4
T_8- Rhizobium+ PSB	38.5	37.5	7.70	7.3	4.20	5.7
S.E.	4.97	5.20	0.78	0.92	1.22	1.60
CD (5 %)	10.24	10.71	1.61	1.89	2.51	3.29

Table-6 *Effect of different treatments on grain straw yield (kg/ha) and Test weight (1000 seed) when boiler ash was used as carrier for bio-fertilizer production*

Treatment	Grain Yield (Kg/ha)		Straw yield (kg/ha)		Test weight	
	2019	2020	2019	2020	2019	2020
T_1-Control	820	810	1646	1600	40.0	40.2
T_2-RDF(100%) (20:60:40)	1028	1050	2100	1980	40.1	40.3
T_3-RDF(100%) + PSB	1080	1088	2160	2100	40.0	40.2
T_4-RDF(100%) + Rhizobium	1078	1080	2200	1990	40.2	40.3
T_5-RDF(100%) + PSB + Rhizobium	1150	1126	2290	2110	40.8	40.6
T_6- Rhizobium	850	878	1500	1560	40.2	40.2
T_7- PSB	870	900	1510	1520	40.2	40.3
T_8- Rhizobium+ PSB	900	920	1800	1910	40.2	40.3
S.E.	35.60	39.20	45.10	39.80	0.78	0.62
CD (5 %)	73.33	80.75	92.90	81.98	NS	NS

Table-7 *Effect of different treatments on N, P, and K update when boiler ash was used as carrier for bio-fertilizer production*

Treatment	N Update (kg/ha)		P Update (kg/ha)		K Update (kg/ha)	
	2019	2020	2019	2020	2019	2020
T_1-Control	72.10	75.20	6.97	6.80	46.0	46.20
T_2-RDF(100%) (20:60:40)	95.0	97.10	8.70	8.92	58.10	59.20
T_3-RDF(100%) + PSB	98.0	101.20	9.20	9.30	61.50	62.00
T_4-RDF(100%) + Rhizobium	99.80	100.40	9.16	9.20	62.0	61.30
T_5-RDF(100%) + PSB + Rhizobium	106.20	104.80	9.88	9.60	65.20	64.18
T_6- Rhizobium	78.08	81.10	7.20	7.50	48.00	50.04
T_7- PSB	79.80	83.50	7.50	7.60	49.20	51.30
T_8- Rhizobium+ PSB	83.10	86.20	7.60	7.90	51.30	52.40
S.E.	8.25	9.10	1.90	2.25	6.72	7.10
CD (5 %)	16.99	18.74	3.91	4.63	13.84	14.62

Among the two different carriers we have found slight increase in the grain yield in case of Potash rich ash as compared to boiler ash, may be due to additional potash must have helped in increasing the same.

The result reveals that available nitrogen, phosphorus and potassium were higher in those treatments, where integration of nutrient sources was followed. It may ensure the optimum nutrient supply throughout the crop cycle. Higher available NPK in these treatments may be due to addition of higher biomass in the form of leave fall and roots which may have build up the organic matter level in soil which contains a substantial amount of NPK and improvement in the physico- chemical properties of soil. Similarly due to biological nitrogen fixation and solubilization of insoluble phosphate owing to Rhizobium and PSB inoculation available NPK may increase as a consequence the uptake of NPK by plants increase and the vegetative as well as reproductive growth increase which ultimately affects the grain yield of urad bean. Rajkhowa (2003) [9] and Mohan (2007) [10] also reported that availability of NPK in soil and uptake by plant increased due to combined application of chemical fertilizer and biofertilizer Jat *et al.* (2006) [11] and Jain (2003) [12] also reported that available N in soil increased due to inoculation of Rhizobium with or without PSB, over control while soil P content remained unaffected by Rhizobium alone but improved with Rhizobium + PSB over no inoculation. Higher availability of nutrients in soil and consequently higher uptake of nutrients by plants increase the plant height, pod weight, grain weight per plant and ultimately grain yield of urad bean].

Nutrient content and uptake

Nitrogen

Assimilation of nitrogen by grain as shown in [Table-4] was affected significantly by different treatments. The highest nitrogen uptake (111 kg /ha) observed in T5 was significantly higher than the treatments other than T3 and T4. Nitrogen uptake in T3 (99.5 kg/ha) and (100.65 kg /ha) in T4 were found statistically at par with the N uptake of T5. Significantly lowest N uptake than the remaining treatments was found in T1 (70.7 kg/ha) where no fertilizer was applied. The highest N uptake 116.2 kg /ha was observed with the T5, which was significantly higher than the T1, T6, T7 and T8 . Minimum N uptake was observed with the T1 (control).

Phosphorus

P uptake in urad under different treatments varied significantly [Table-4]. The maximum P uptake 10.5kg/ha was observed with in T5, which was significantly higher than the treatments where either only organic sources were applied to supply N and P or 100% N P was applied through chemical fertilizers. Minimum P uptake 6.67 kg/ha was observed in T1 (control), among other treatments T3 &T4 was at par with T5 in P uptake. With exception ofT6, T7 and T8 the P uptake under remaining treatment was more or less similar. Phosphorus assimilation was comparatively lower in those treatments where only organic sources were applied. Phosphorus assimilation by urad in T1 was lowest and it differs significantly from rest of the treatments with exception of T6 & T7.

Potassium K

K uptake was affected significantly by different treatments [Table-4]. The highest K concentration 66.15 kg/ha was in T5 and T4 and which was significantly higher than the K content found in T1. This shows that grain and straw K content in the treatment of integration was similar to those where only organic sources were applied for nutrition. Accumulation of K in T3 and T4 was similar. Due to integration of nutrient sources K assimilation increased significantly over T1.

Conclusion

From the above study, it can be concluded that the application of Rhizobium and PSB along with recommended dose of fertilizer gave best result and proved to be beneficial. Grain yield increased by 44% due to application of biofertilizers with inorganic fertilizers. Potash rich Ash from distillery and boiler ash form sugar factory could be successfully and efficiently used as a carrier for Rhizobium and PSB based biofertilizers. Ashes could be successfully utilized as carrier for bio-fertilizer to increase the yield of Urad crop in terms of growth parameters and yield attributing characters.

Application of research: Solid waste management as the ashes from distillery or sugar factory instead of land filling can be used as carrier for production of bio-fertlizers and can generate further revenue for sugar industry.

Research Category: Solid waste management

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Institute: National Sugar Institute, Kanpur, 208017, Uttar Pradesh, India
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Author Contributions: All authors equally contributed

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Study area / Sample Collection: Biochemistry & Agriculture Chemistry Division, National Sugar Institute, Kanpur, 208017, Uttar Pradesh, India

Cultivar / Variety / Breed name: Urad Bean (*Vigna mungo*)

Conflict of Interest: None declared

Ethical approval: This article does not contain any studies with human participants or animals performed by any of the authors.
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