EFFECT OF PADDY HUSK ASH AS A SOURCE OF POTASSIUM ON THE PERFORMANCE OF COWPEA (*VIGNA UNGUICULATA*) IN SANDY REGOSOL

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ABSTRACT

An experiment was conducted at the Agronomy farm, Eastern University, Sri Lanka to study the effect of paddy husk ash as a source of potassium on the performance of cowpea (*Vigna unguiculata)* in sandy regosol. The treatments included recommended rate (75 kg/ha) of muriate of potash (T_1) and application of paddy husk ash at the rate of 1500 (T_2), 2500 (T_3), 3500 (T_4) and 4500 (T_5) kg/ha. This experiment was laid out in a Randomized Complete Block Design (RCBD) with five treatments and four replications in sandy regosol. Before being carried out the research work, potassium and phosphorous contents and the pH of the soil at the experimental site and paddy husk ash used in this experiment were analyzed. The agronomic parameters such as plant height, number of leaves, total biomass of plant and harvest index were recorded. Potassium content of cowpea seeds were also analyzed after harvest of pods.

The present results revealed no significant differences in plant height and number of leaves among treatments. Significant difference was observed in total biomass among treatments. Application of paddy husk ash at the rate of 4500 kg/ha (T_5) gave the highest biomass (0.068 kg/ plant) followed by T_4. Treatments showed significant difference in weight of cowpea seeds per plant. Application of paddy husk ash at the rate of 4500 kg/ha (T_5) gave the highest seed weight per plant (0.017 kg/plant) and muriate of potash at the rate of 75 kg/ha (T_1) gave second highest weight (0.016 kg/plant). Harvest index was higher in the treatment with recommended rate of muriate of potash (T_1)(28.2%) followed by treatment with the application of paddy husk ash at the rate of 4500 kg/ ha (T_5)(24.2%). Potassium (1.46 g) content in 100 g cowpea seeds was slightly high in the treatment with recommended rate of muriate of potash (T_1)than other treatments and in T_5, potassium content was 1.44 g. After the harvest of crop, the soil pH and potassium content of soil increased with the increasing rate of application of paddy husk ash. The soil potassium content after harvest was high in T_5 (0.193 %) followed by T_4 (0.191 %) and T_1 (0.191 %). In this study, the application of paddy husk ash at the rate of 4500 kg/ ha (T_5) would be more suitable for obtaining high yield and the paddy husk ash has the positive effect on cowpea cultivation as a source of potassium fertilizer.

INTRODUCTION

Cowpea is a grain legume of the leguminosae family and the main source of dietary protein for the people, especially for the large vegetarian population. Grain legumes can thrive under a range of agro climatic condition. Being a drought tolerant and warm weather crop, cowpea is well adapted to the drier regions of the world. In modern agriculture, the world depends upon the external application of plant nutrients to meet crop needs. The main reason for human intervention in the natural nutrients supply system is that soil reserves or natural recycling cannot be provided the very large amounts of nutrients needed year after year to harvest the quantum of crop produce required for human consumption and as industrial inputs. Chemical based farming makes considerable amount of degradation to natural resources, particularly soils. Heavy application of fertilizers causes problems such as diminishing soil productivity and multiple nutrient deficiencies. Depletion of non renewable sources of energy, escalating cost of fertilizers and environmental quality aspects also emerged as important issues. This necessitated a review of various approaches focusing on the use of available renewable resources of plant nutrients for complementing and supplementing the commercial fertilizers. Recycling agricultural wastes can help a developing country to reduce its dependence on foreign energy supplies and raise the standard of living in its rural areas (Pequegnat, 1975).

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In Batticaloa district, the paddy husk is highly available soil amendment in large quantities, which improves water retention of sandy regosol effectively. According to the research, in the majority of rice processing areas, husk is considered as waste material and its disposal often create environmental problems. Therefore it can be used as potassium source for crop production. This technology is best suited to small-scale farming. Potassium is one of sixteen essential nutrients required for regulatory roles in biochemical and physiological functions of plant growth (Marschner, 1995). Cowpea is cultivated throughout the year in all agro ecological regions and the paddy husk ash is highly available soil amendment in large quantities in Sri Lanka. Despite the foregoing, the use of paddy husk ash has not received considerable attention. Therefore, an attempt was made to study the effect of paddy husk ash as a source of potassium on the performance of cowpea in sandy regosol.

MATERIALS AND METHOD

The experiment was conducted at the Agronomy farm, Eastern University, Sri Lanka to study the effect of paddy husk ash as a source of potassium on the performance of cowpea (*Vigna unguiculata)* in sandy regosol. This experiment was laid out in a Randomized Complete Block Design with five treatments and four replicates. Before being carried out the research work, potassium and phosphorous contents and the pH of the soil at the experimental site and paddy husk ash used in this experiment were analyzed. A size of each plot was 2 m × 2 m. Paddy husk ash as a source of potassium was applied to soil at different levels (1500 kg/ha (T_2), 2500 kg/ha (T_3), 3500 kg/ha (T_4) and 4500 kg/ha (T_5)) and also recommended rate (75 kg/ha) of muriate of potash (T_1) was applied as basal application of fertilizer. Dhawala variety of cowpea was planted in 45 cm between rows and 15 cm between plants. Twelve plants were randomly selected from each treatment to measure the parameters. All the data collected were statistically analyzed by analysis of variance (ANOVA) and pair comparison among treatment mean was tested by using SAS application. One week after harvesting of pods, potassium content in the cowpea seeds and potassium of the soil were analyzed.

RESULTS AND DISCUSSION

Plant height

Plant height is an important factor to be considered as it justifies the growth of the plant. The effect of different treatments on plant height is presented in Table1. Plant heights were not significantly varied ($p > 0.05$) among the treatments during their growth period. It might be due to the source of potassium that did not affect the plant height. This trend of result is very much similar with those of Balliu and Ibro (2002) who mentioned that there was no statistical difference found in the mean of plant height in the effect of different levels of potassium fertilizer on plant growth. It is also supported by Melton and Dufault (1991) who found that potassium did not significantly influence any of the growth variables of tomato plants on plant height.

Table 1: Effect of paddy husk ash on plant height of cowpea

	Plant height (cm)		
Treatments	**At 1st week**	**At 3rd week**	**At 5th week**
T_1	13.20±0.21	27.99±0.89	45.16±2.42
T_2	13.14±0.43	26.99±0.59	43.25±2.32
T_3	13.04±0.32	26.50±1.00	43.66±1.53
T_4	13.20±0.44	27.45±0.78	45.24±2.67
T_5	13.16±0.30	2 7.70±0.57	44.83±1.99
F test	ns	ns	ns

Number of leaves

Numbers of leaves of plant of each treatment at different periods are given in Table 2. The results showed that there were no significant differences in number of leaves among the treatments at different growth period. At the 1st and 3rd weeks, all of the treatments showed the similar result. This result is in agreement with the finding of Balliu and Ibro (2002), who reported that there was no statistical difference found in the mean number of leaves in the effect of different levels of potassium fertilizer on plant growth. It is also supported by Melton and Dufault (1991) who found that potassium did not significantly influence any of the growth variables of tomato plants on number of leaves. Although, no significant difference found at 5th week, the lowest number of leaves (19.91) was found in treatment with application of muriate of potash at rate of 75 kg/ha (T_1) and the higher value (22.50) was recorded in the treatment with 4500 kg/ha paddy husk ash (T_5) this may be due to the improvement of soil structure by the application of paddy husk ash before planting.

Table 2: Effectof paddy husk ash on number of leaves

	Number of leaves		
Treatments	**At 1st week**	**At 3rd week**	**At 5th week**
T_1	3.08±0.83	7.74±0.43	19.91±1.65
T_2	3.08±0.83	7.66±0.45	20.08±0.76
T_3	3.08±0.83	7.75±0.55	20.91±0.97
T_4	3.08±0.83	7.75±0.55	21.41±1.91
T_5	3.08±0.83	7.74±0.69	22.50±2.48
F test	ns	ns	ns

Biomass

The summary of result pertaining to biomass production as recorded in mean dry weight at harvest is presented in Table 3. There were no significant differences ($p>0.05$) in the mean dry weights of stem, leaves and roots but significant differences ($p<0.05$) were found in mean dry weights of pods and seeds. Total biomass were showed significant difference ($p<0.05$) among the treatments. The mean biomass ranged from 0.047 kg/plant (T_2) to 0.068 kg/plant (T_5). Application of paddy husk ash at the rate of 4500 kg/ ha (T_5) gave highest biomass (0.068 kg/plant) followed by treatment of paddy husk ash at the rate of 3500 kg/ ha (T_4) (0.064kg/plant) and recommended rateof muriate of potash (T_1) (0.057 kg/plant). Treatments showed significant difference on weight of cowpea seeds per plant. Application of paddy husk ash at the rate of 4500 kg/ha (T_5) gave the highest seed weight (0.017 kg/plant) and muriate of potash at the rate of 75 kg/ha (T_1) gave second highest seed weight (0.016 kg/plant). It was further noted that seed weight per plant was gradually increased with increase in application rate of paddy husk ash. Asghar *et al.* (1994) reported that improvements such as increased number of branching, pod bearing or number of seeds per pod could possibly be because of improved N and P utilization efficiency in the presence of K in black gram. Further he mentioned that these macro-elements have been found to show complimentary role for each other. Similar observation was also reported by Ayyoub (1985).

Harvest index

Harvest index define as economic yield over biological yield. The analysis of variance for harvest index revealed that treatments had significant effect ($P<0.05$) on the harvest index (Table 3). T_1 significantly differed from other treatments. The average percentage of harvest index ranged from 19.63% (T_2) to 28.22% (T_1). It was further noted that harvest index of treatments with application of paddy husk ash at the rate of 4500 kg/ha (T_5) and (T_1) was 24.2%. The data regarding harvest index showed that it was gradually increased with increase in amount of potassium. It was supported by Asghar *et al.* (1994) who reported that maximum number of pod bearing branches per plant and number of seeds per pod were produced with K_20 application at the rate of 75 kg/ha and the results on seed weight per plant indicated a significantly positive effect of K in black gram. In general, K application produced significantly higher number of pods per plant and higher seed weight per plant than the control. The seed yield increased progressively with increasing the rate of K_20. Similar results were also reported by Shabbir (1982) in chickpea.

Table 3: Effect of paddy husk ash on total biomass and harvest index

Treatments	Biomass (kg/plant)	Seed weight/plant (kg/plant)	Harvest index (%)
T_1	0.057±0.002b	0.016± 0.001a	28.22±0.95a
T_2	0.047±0.003c	0.009± 0.001b	19.63±0.66c
T_3	0.056±0.003b	0.011± 0.001b	20.67±0.53c
T_4	0.064±0.002a	0.015±0.001a	24.18±0.74b
T_5	0.068±0.001a	0.017± 0.001a	24.20±1.35b
F test	*	*	*

Value represents mean± standard error of four replicates.
F test:*: $P<0.05$
Means followed by the same letter in a column are not significantly different according to Duncan's Multiple Range Test at 5% level

Analysis of paddy husk ash

Paddy husk ash that used in this experiment contained 1.31% potassium and 0.66% phosphorous. pH of ash was 8.98. These results are in agreement with the analysis of Prasong (2003) who reported that potassium and phosphorous contents of paddy husk ash were 0.01-2.69% P_2O_5 and 0.1-2.54% K_2O respectively and the pH was 8.1-11.

Analysis of soil

The potassium and pH of the soil collected at the experimental site were analyzed before planting and after harvest of crop. The results are shown in Table 4. Before being carried out the research soil pH and potassium content were low however after harvest of pods, soil pH and potassium content were high and also it showed difference among treatments. According to the results obtained, the pH of the soil had increased with the increasing application rate of paddy husk ash. This is in agreement with the result of Okan (2005) who showed the paddy husk ash increases the soil pH, thereby increasing available phosphorous. Soil potassium content after the harvest of crop showed difference among the treatments, high potassium level was found in the application rate of 4500 kg/ha paddy husk ash (T_5) and the low level was recorded in the application of paddy husk ash at a rate of 1500 kg /ha (T_2). This is confirmed by Ichibancho and Chiyodaku (2001) who found that paddy husk ash increases the water holding capacity and level of exchangeable potassium and magnesium in soil.

Table 4: Potassiumand pH of soil at the experimental site before planting and after harvest of pods

	Before planting	After harvest of pods				
		T_1	T_2	T_3	T_4	T_5
P^H	6.80	6.98	7.08	7.15	7.29	7.49
Potassium (%)	0.12	0.191	0.13	0.168	0.191	0.193

Analysis of product

According to the result (Table 5), the potassium content in seeds did not differ much from each treatment, the K contents in the application of muriate of potash at the rate of 75 kg/ha (T_1) and application rate of 4500 kg/ha paddy husk ash (T_5) were 1.46 % and 1.44% respectively. The lowest (1.33 %) was found in application rate of 1500 kg/ha paddy husk ash (T_2). Asante *et al*. (2007) showed potassium content in matured seeds of cowpea contained per 100 g edible portion ranged between 859.5 mg to 1905.0 mg. Ichibancho (2001) reported that paddy husk ash also increases the water holding capacity and level of exchangeable K and Mg. This technology is best suited to small scale farming. It is an effective for cowpea. It is also worth trying for other field crops and vegetables.

Table 5: Potassium content in 100 g cowpea seeds

Treatment	Potassium (g/100 g seed)
T_1	1.46
T_2	1.33
T_3	1.35
T_4	1.39
T_5	1.44

CONCLUSION

There were no significance differences found in plant height and number of leaves among treatments. The growth, nodulation, seed weight per plant, total potassium content of seed of cowpea increased with the increasing application rate of paddy husk ash. Total biomass and harvest index were showed significant differences. Application of paddy husk ash at the rate 4500 kg/ha (T_5) gave highest biomass (0.068 kg/plant) and second highest of harvest index (24.2%). Seed potassium content was high in recommended rate of potassium (T_1) however application of paddy husk ash at the rate of 4500 kg/ha (T_5) showed nearly similar result of T_1. After the harvest, the soil pH and potassium content of soil increased with the increasing rate of application of paddy husk ash. Therefore, it can be concluded that application of paddy husk ash as a potassium source at a rate of 4500 kg/ha is more favourable for obtaining high yield and improving soil characteristics and we can use paddy husk ash as a source of potassium instead of muriate of potash (chemical fertilizer). Application of paddy husk ash is best suited to small scale farming in Sri Lanka.

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