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The Residual Effect of Paddy Husk Ash Applied to Proceeding Crop of Cowpea (*Vigna unguiculata* L.) On Succeeding Crop of Amaranthus (*Amaranthus tricolor* L.)

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Abstract: A field experiment was conducted at Crop Farm, Eastern University, Sri Lanka during 2008/2009 to study the residual effect of paddy husk ash applied to proceeding crop of cowpea on succeeding crop of amaranthus (*Amaranthus tricolor* L.). During proceeding crop cultivation instead of inorganic potassium, paddy husk ash as a source of potassium was applied to soil at different levels as basal application of fertilizer. Treatments included are muriate of potash at the rate of 75 kg/ha (T1) and also paddy husk ash at the rate of 1500 kg/ha (T2), 2500 kg/ha (T3), 3500 kg/ha (T4) and 4500 kg/ha (T5). Immediately after proceeding crop cowpea harvested, amaranthus was cultivated as succeeding crop without disturbing the plots. Experiment was design in Randomized Complete Block Design with four replications. At harvest plant height, leaf area, root length and fresh and dry weights of leaf, stem and root were measured. The present study revealed that there were significant differences ($P<0.05$) in plant height, root length, fresh and dry weights of leaves and leaf area. It was high in T5 followed by T4. Fresh and dry weights of root and stem were not affected by paddy husk ash residual potassium compared to inorganic residual potassium. This study revealed that paddy husk ash applied at the rate of 4500 kg/ha (T5) would be suitable to provide sufficient amount of residual potassium for amaranthus growth.

Key words: Muriate of potash · Paddy husk ash · Proceeding crop · Succeeding crop

INTRODUCTION

The impact of fertilizer on crop productivity is substantial and plays an important role in improving the yield and quality of horticultural crops. Potassium is one of the three major crop nutrients required for plant growth and reproduction. In the plant tissue, the content of K is higher than that of other cations [1]. It is the most important one in many physiological and biochemical process. An adequate K supply is necessary to ensure crop resistance to lodging, pest and disease, drought and it plays a key role of crop quality [1]. Also K is vital for the formation of chlorophyll, development of root system and improves the water use efficiency. K deficiency may restrict a crop's ability to utilize nitrogen. In nutshell, K is important for overall performance of the plant development.

Potassium is supplied by inorganic fertilizers such as muriate of potash or sulphate of potash or complex fertilizers, or by some organic sources. Paddy husk is a major agricultural by product in Sri Lanka and a large quantity of paddy husk is being disposed, causing atmospheric and water pollution. This disposal method is now opposed and prohibited. Paddy husk is making as useful one. Paddy husk ash contains potassium and phosphorus, which are sufficient for some crop growth and their development. Amount of potassium varies with the temperature and time which the husk burnt, therefore it can be used as potassium source for crop production. The ash also increases the water holding capacity and amendment the soil property.

Among the leafy vegetables, amaranthus is very common due to its easiness in culture, nutritive value, fast growth rate, adaptability to varying agro climates, high yield potential. It fits well in a crop rotation because of its very short duration and large yield of edible matter per unit area. Amaranthus is one of the most delicious leafy vegetables cultivated and consumed in many part of the world. And also it is probably the highest yielding leaf vegetable of the tropics. It has excellent nutritional value. Amaranthus is a green leafy vegetable rich ascorbic acid and beta-carotene, which can be locally grown

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and can be recommended in the diet of the poor people to eradicate malnutrition and blindness [2]. It is quite nutritious both the seeds and the vegetables contain protein of an unusual high quality and high percentage vitamin, iron, carotene, calcium, folic acid and protein are especially high. Especially leafy vegetables play a vital role in human daily diet. In Sri Lanka, leaves and stems are eaten in various dishes as raw and cooked. They are excellent raw in salads, used as a steamed vegetable and included in soups and stews. Vegetable amaranthus are recommended as a good food with medicinal properties for young children, lactating mother and patients with fever, hemorrhaged, anemia and kidney complaints.

Paddy husk is biodegradable and it can be converted into valuable resources. Amaranthus is a crop which requires a high level of soil fertility and which is exhausting for the soil. A number of field trials have shown that amaranthus has a good response to NPK-fertilizing with high potassium content [3]. Soils with a high organic content and with adequate nutrient reserves are required for optimum yield. Optimum pH range is 5.5 -7.5. But some cultivars can tolerate more alkaline condition. Surface dressings of nitrogenous fertilized are normally required during active growth. In some areas additional, application of potassium may also be required. Due to theses reasons, amaranthus was selected as succeeding crop to proceeding crop of cowpea in sandy regosol.

MATERIALS AND METHODS

An experiment was conducted at the Crop Farm, Eastern University, Sri Lanka during 2008/2009 to evaluate the residual effect of paddy husk ash applied to proceeding crop of cowpea on succeeding crop of amaranthus. The Crop Farm is located at Eastern region, Sri Lanka. It comes under the agro ecological zones of low country dry zone between 7° 43' N and 81° 42' E, elevation 5 meter above sea level. Optimum temperature is 31°C and annual rain fall is 1600mm. The soil of experimental site is sandy regosol.

During proceeding crop cultivation, paddy husk ash as a source of potassium was applied to soil at different levels as basal application of potassium fertilizer as follows.

Treatment 1: Muriate of potash at the rate of 75 kg/ha (control)
Treatment 2: Paddy husk ash at the rate of 1500 kg/ha
Treatment 3: Paddy husk ash at the rate of 2500 kg/ha
Treatment 4: Paddy husk ash at the rate of 3500 kg/ha
Treatment 5: Paddy husk ash at the rate of 4500 kg/ha

Immediately after cowpea (proceeding crop) harvested, amaranthus was cultivated as a succeeding crop. This experiment was laid out in a Randomized Complete Block Design with five treatments and four replicates. Plot area was 2 m × 2 m. Each block was separated by 1 m wide path and the space between the plots was 0.5 m. Agronomic practices were followed as recommended by Department of Agriculture, Sri Lanka. Twenty five days after sowing, five plants were randomly selected from each plot. Plant height, root length and also fresh and dry weights of plant were measured. Collected data were statistically analyzed, significant differences between the treatments were determined using analysis of variance (ANOVA) for factorial experiment in RCBD using SAS software and the treatment means were separated using Duncan's Multiple Range Test at 5% level.

RESULTS AND DISCUSION

Plant Height: Plant height of amaranthus is shown in Table 1. There was significant difference among treatments. T5 significantly differed from other treatments except T4. It ranged from 30.74 cm (T2) to 36.91 cm (T5). Application of paddy husk ash at the rate of 3500 and/ or 4500 kg/ha, increased plant height. Increasing vegetative growth due to increasing potassium fertilizer levels has been reported by Chen *et al.* [4], Gupta and Sengar [5] and Sun *et al.* [6] on eggplant and Koteponge*t al.* [7] on tomato plant. They indicated that K application resulted in increase the plant height. It may be the reason for taller plants in T5 followed by T4.

Leaf Area: The analysis indicated that leaf area per plant significantly differed ($P<0.05$) among the tested treatments (Table 2). Average leaf area per amaranthus ranged from 179.96 (T1) to 221.73 (T5). The efficiency of agricultural production depends on the utilization of sunshine for photosynthesis by crop plant [8]. Compared with inorganic K applied plot, paddy ash applied plots had high leaf area. It was high in T5 followed by T4. This data suggested that paddy husk ash residual K may increase the photosynthesis via increase the leaf area.

Root Length: Root length of amarathus in each treatment is shown in Table 3. Root length was high in T5 followed by T4. Compared with other treatments, applied K was

Table 1: Average plant height of amaranthus in each treatment

Treatments	Plant height (cm)
T1	31.24±1.92b
T2	30.74±0.91b
T3	31.33±0.83b
T4	34.25±1.25ab
T5	36.91±1.58a
F test	*

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

Table 2: Average leaf area of amaranthus

Treatments	Leaf area
T1	179.96±4.22d
T2	187.18±1.33cd
T3	196.13±1.85bc
T4	205.15±1.49b
T5	221.73±6.53a
F test	*

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

Table 3: Average root length of amaranthus in each treatment

Treatments	Root length (cm)
T1	13.25±1.75b
T2	12.75±0.75b
T3	12.41±1.58b
T4	15.60±0.05a
T5	16.41±0.75a
F test *	

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

high in T5 followed by T4. K is essential for the development of the root system [1]. This may be the reason for longer root in T5 followed by T4.

Fresh Weight of Plant: There was significant difference in fresh weight of plant. It was high in T5 (44.54 g) as shown in Table 4. Compared with inorganic fertilizer applied plot, plant weight was high in paddy husk ash applied plots. Residual K may be high in T5 followed by T4. Each unit of K gives a high yield response [9]. This may be the reason for high fresh weight in T5 followed by T4.

There was significant difference in fresh weight of leaf. T5 significantly differed from other treatments except T4. Nitrogen is vital for leafy growth of plant. K improves nitrogen utilization [9]. This may be the reason for high leaf weight in T5 (14.65 g). There were no significant differences in stem and root fresh weights. It suggest that stem and root fresh weights of amaranthus was not affected by residual K.

Dry Weight of Plant: There was significant (P<0.05) difference among treatments in leaf dry weight. It ranged from 9.23 g (T1) to 10.77 g (T5). It was high in paddy husk ash applied at the rate of 4500 kg/ha plot and low in Muriate of potash applied at the rate of 75 kg/ha plot. High K application may be the reason for high dry weight of leaf. K application resulted in increases in dry matter accumulation in cotton [10]. There was no significant difference in dry weights of stem and root. It may suggest that dry weight of plant was not significantly affected by residual K.

Table 4: Fresh weights of amaranthus (g)

Treatments	Plant fresh weight	Leaf fresh weight	Stem fresh weight	Root fresh weight
T1	38.88 ± 0.91c	13.42 ± 0.65b	21.16 ± 0.36	4.55 ± 0.56
T2	40.79 ± 0.53bc	13.41 ± 0.25b	21.91 ± 0.86	4.97 ± 0.31
T3	41.31 ± 0.43b	13.43 ± 0.12b	21.74 ± 1.26	4.80 ± 0.59
T4	42.73 ± 0.60ab	14.4 ± 0.20ab	22.02 ± 0.08	5.18 ± 0.04
T5	44.54 ± 0.65a	14.65 ± 0.09a	22.57 ± 1.09	4.95 ± 0.23
F test	*	*	ns	ns

Value represens mean± standard error of five replicates
F test:*: P<0.05, ns: not significant
Means followed by the same letter are not significantly different according to Duncan's Multiple Range Test at 5% level

Table 5: Dry weight of plant (g)

Treatments	Root dry weight	Stem dry weight	Leaf dry weight
T1	2.26 ± 0.06	10.34 ± 0.05	9.23 ± 0.49 ab
T2	2.33 ± 0.05	10.45 ± 0	10.03 ± 0.02 ab
T3	2.30 ± 0.04	10.43 ± 0.06	10.29 ± 0.06 a
T4	2.34 ± 0.07	10.41 ± 0.17	10.54 ± 0.33 a
T5	2.34 ± 0.07	10.43 ± 0.12	10.77 ± 0.09 a
F test	ns	ns	*

Value represents mean± standard error of five replicates
F test:*: P<0.05, ns: not significant
Means followed by the same letter are not significantly different according to Duncan's Multiple Range Test at 5% level

CONCLUSION

This study revealed that there were significant differences ($P<0.05$) in plant height and root length. It was high in T5 followed by T4. In case of fresh weights, there was significant difference in fresh weight of plant and leaf. Both fresh weights, T5 significantly differed ($P<0.05$) from other treatments except T4. Residual K affects leaf area. Compared with paddy husk applied plot, inorganic fertilizer applied plot has low leaf area. T5 not significantly differed from other treatments in case of dry weight of leaf. It was high in T5 followed by T4. Fresh and dry weights of root and stem were not affected by paddy husk residual K compared to inorganic residual K. This study revealed that paddy husk ash applied at the rate of 4500 kg/ha would be the most suitable amount to provided sufficient amount of residual K for amaranthus growth.

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