EFFECT OF POTASSIUM AND ORGANIC MANURES ON THE GROWTH PERFORMANCE OF COWPEA (Vigna unguiculata) IN SANDY REGOSOLS

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ABSTRCT: *In Sri Lanka due to continuous changes in climate, drought is becoming as a serious problem in Agriculture. Batticaloa district is one of the intensive agricultural region in the eastern province of Sri Lanka and mostly affected by drought during yala season. Major soil group found in this region is sandy regosols. According to the characteristics of sandy regosols it is low in agricultural value. Therefore proper management practices should be adopted to improve the performance in agricultural productivity.*

Soil moisture is the principal environmental factor that limiting the legume productivity in tropical countries. Potassium fertilization facilitates the crops to survive under drought stress and helps to obtain better performance.

A pot experiment was carried out at Eastern University, Sri Lanka during the period of July to September 2018, to evaluate the effect of organic manures and rate of potassium on the growth performance of cowpea (Vigna unguiculata) in sandy regosol using variety wijaya. There were eight treatments combining cow dung and compost with muriate of potash at the rate of 100%, 125%, 150% and 175% of recommendation and were replicated three times in two factor factorial completely randomized design (CRD).

Among the organic manures compost showed highest growth performance than cow dung. Increasing rate of potassium increased the growth and yield of cowpea and highest yield was obtained at the combination of compost with 175% recommendation of MOP. Therefore combination of compost with increasing rate of MOP can be suggested to farmers especially for the cultivation of cowpea on sandy regosols in order to obtain best growth and yield performance and to indirectly avoid excess watering during drought condition.

Key words: Compost, Cowpea, Cow dung, MOP, Potassium

1. INTRODUCTION

Sri Lanka has diversity of soil type, among them regosol is one of the major soil group found in the dry zone of Sri Lanka and is found along or near the coastline such as Kalpitiya, Nilavelly and most parts of Batticaloa district (Panabokke, 1996). Batticaloa district is one of the intensive agricultural area in the eastern province of Sri Lanka. According to the characteristics of the sandy regosol it is low in agricultural value and these soils are light sandy textured with very low exchange properties (CEC <2 cmol kg-1) Thereby their nutrient supplying capacity is very low (Imsamut and Boonsompoppan, 1999). In addition their water holding capacity and organic matter content is very low. Therefore proper management practices should be adopted.

In Sri Lanka climate change is becoming as a major threat in the Agricultural sector. Due to the climate change expected rainfall amount and intensity may not occur at expected time. Due to the less intensity of rainfall and increasing temperature causes to drought. Drought is a major factor limiting productivity in agriculture and have caused a collapse in food production by reducing uptake of water and nutrient (Du, *et al*., 2010). In Sri Lanka about 66% of cropland is rain-fed (Biradar, *et al*., 2009) and therefore increasingly vulnerable to the impacts of climate variability and extremes. So climate change impacts should be overcome by appropriate management strategies.

Food legumes are important component of the Agricultural sector in Developing countries due to their significant capacity of protein rich seed production. Cowpea is an important leguminous crop grown in Sri Lanka. It is grown in both Maha and Yala season as a monocrop and an intercrop. It is used as green vegetables, pulses and also fodder. It plays an important role in human diet and has its importance in Agriculture for various cropping systems. Soil moisture is the principal environmental factor that limiting the legumes productivity in Tropical countries (De Costa, *et al*., 1999 and Carranca, *et al*., 1999).

Potassium (K^+) is an essential element for plant growth and development and is the most abundant cation in plants, and increasing plant's total dry weight by 3–5% (Marschner, 1995). This macronutrient is essential for many plant processes such as enzyme activation, protein synthesis, photosynthesis, osmoregulation during cell expansion, stomatal movements, solute phloem transport, electrical neutralization, regulation of membrane potential, transport of sugars, and the maintenance of cation–anion balance in the cytosol as well as in the vacuole (Maser, *et al*., 2002). Drought is a significant limiting factor for agricultural productivity and generally inhibits plant growth through reduced water absorption and nutrient uptake. Decreased water availability generally results in reduced growth and final yield in crop plants. Potassium ions contribute significantly to the osmotic potential of the vacuoles even under drought conditions (Marschner, 1995). Plants adopted different mechanism to survive with the different stresses. The use of minerals plays an important role in plants resistance against the abiotic stresses. Among the nutrients, Potassium (K^+) plays an important role in growth and development and contributes significantly towards the plants survival under drought stress (Hassan, *et al*., 2017).

Water Holding Capacity of soil is controlled primarily by the number of pores and specific surface area of soil. Water Holding Capacity is increased when the number of small pores increases. Sandy soils have much less surface area than clay soils, thus retain less water at higher tensions. Addition of organic manures increases the specific surface area and resulting in increased Water Holding Capacity. Soil texture and organic manures are the key components that determine the soil water holding capacity and the water retain by the organic manure is used by the plants and this addition enhances plant growth and improves water use efficiency (Vengadaramana and Jashothan, 2012).

Climate change is one of the major challenge for Agriculture. Drought causes severe problems in cowpea cultivation in Eastern Region of Sri Lanka. Adding organic manures increases the Water Holding Capacity and application of potassium reduces the moisture stress in cowpea. But the level of potassium and type and amount of organic manure can applicable to increase the performance of cowpea is scanty. Thereby the present study was contemplated to determine the effect of organic manures and rate of potassium on the growth performance of cowpea (variety wijaya).

2. METHODOLOGY

2.1. Description of experimental site

A pot culture experiment was conducted during yala season at Eastern University, Sri Lanka, which is located in the low country, dry zone and DL2 agro ecological zone. The monthly average temperature and humidity were 30-36ºC and 66-81% respectively during the experiment period. Experiment was conducted from July to September, 2018 to study the effect of potassium and organic matters on the growth performance of cowpea (*Vigna unguiculata*) in sandy regosols.

2.2. Description of soil and organic manures used in the experiment

The soil used in this study was sandy regosol. It belongs to the group of Tropofluvents according to the USDA soil taxonomy (De Alwis and Panabokke, 1972). Organic manures used in this experiment were cow dung and compost and their available potassium contents were 0.67% and 0.53% respectively.

2.3. Treatments and Experimental design

The treatments were evaluated to select the best combination of organic manure and rate of potassium to tolerate the drought condition in sandy regosol at Batticaloa region. The treatment combinations were laid out in two factor factorial Completely Randomized Design and there were eight treatments with three replicates. Cow dung and compost were used at the rate of 10 tons/ha and MOP was added at 100%, 125%, 150% and 175% of fertilizer recommendation of Department of Agriculture, Sri Lanka. Urea and TSP were applied at the rate of 30kg/ ha and 45kg/ha. The treatments were,

O1K0- cow dung + 100% MOP

O1K1- cow dung + 125% MOP

O1K2- cow dung + 150% MOP

O1K3- cow dung + 175% MOP

O2K0- compost + 100% MOP

O2K1- compost + 125% MOP

O2K2- compost + 150% MOP

O2K3- compost + 175% MOP

2.4. Planting

A bulk soil sample was collected from an area where cultivation was not previously carried out at 0-20 cm depth. The collected soil sample was processed and air dried for a day. Then it was sieved (2mm mesh sieve) to avoid the soil heterogeneity. Each polyethylene bag was filled with 7 kg processed soil. According to the treatments, organic manures and fertilizers were incorporated in to the soil 3 days prior to the planting. Pre-treated seeds were sown in each bag and two plants per bag were maintained.

2.5. Watering

Water holding capacity of sole soil and soil with organic manures were measured in volume basis. Watering was done according to the weight loss of individual treatments at two days interval to maintain the required water holding capacity.

2.6. Measurements

2.6.1. Manure analysis

Available potassium content of manures were extracted by triple acid and analyzed by flame photometric method (Toth and Prince, 1949).

2.6.2 Plant biometric parameters

Plant height was measured at two weeks interval

Leaf area at onset of flowering and at harvesting

Yield

2.7. Analysis of results

The data from experimental plants were statistically analyzed using Analysis of Variance (ANOVA) to detect if there was any significance at treatment level. The differences between treatment means were compared using Duncan's Multiple Range Test (DMRT) using SAS 9.1.3 package.

3. DISCUSSION AND RESULTS

3.1. Plant height

Table 1. Effect of Organic Manure and Rate of Potassium on Plant Height (cm) of Cowpea at two weeks interval

Organic manure	Rate of Potassium (MOP)	2WAP (cm)	4WAP (cm)	6WAP (cm)	8WAP (cm)
Cow dung	**K0 (100%)**	16.233 ± 0.371^{b}	21.333 ± 0.333^{c}	33.500 ± 0.288^{c}	39.833 ± 0.440^{c}
	K1 (125%)	17.166 ± 0.166^{ab}	26.766 ± 0.144^{b}	44.333 ± 0.166^{b}	45.833 ± 0.166^{b}
	K2 (150%)	17.666 ± 0.333^{a}	27.833 ± 0.166^{a}	47.833 ± 0.166^{a}	50.500 ± 0.288^{a}
	K3 (175%)	17.166 ± 0.166^{ab}	27.833 ± 0.166^{a}	47.800 ± 0.416^{a}	51.166 ± 0.166^{a}
Compost	**K0 (100%)**	18.333 ± 0.333^{b}	30.000 ± 0.000^{b}	46.333 ± 0.333^{d}	47.500 ± 0.288^{d}
	K1 (125%)	18.166 ± 0.166^{b}	30.333 ± 0.333^{b}	48.500 ± 0.288^{c}	51.666 ± 0.333^{c}
	K2 (150%)	18.333 ± 0.333^{b}	30.500 ± 0.288^{b}	50.333 ± 0.333^{b}	53.666 ± 0.333^{b}
	K3 (175%)	19.666 ± 0.333^{a}	33.000 ± 0.000^{a}	51.833 ± 0.166^{a}	58.666 ± 0.166^{a}
	Organic manure	$P < 0.05$	$P < 0.05$	$P < 0.05$	$P < 0.05$
	MOP	$P < 0.05$	$P < 0.05$	$P < 0.05$	$P < 0.05$
	Interaction	$P < 0.05$	$P < 0.05$	$P < 0.05$	$P < 0.05$

The values are means of replicates ± standard error

Means at the same letter(s) in same column are not significantly different from each other according to the Duncan multiple range test at 5% significant level.

Highest plant height was recorded at compost with 175% recommendation of compost applied soil. Increasing rate of potassium fertilization increased crop growth. The reason may be potassium is necessary for young growing tissues for cell elongation and possibly for cell division and it is very mobile in plants and therefore circulates freely and has vital role in maintenance of torpor pressure and also helps in several physiological processes and uptake of other nutrient elements (Sadanandan *et al*. 2002). Increasing rate of potassium increased the plant height. This statement was supported by Mohammad *et al.* (2011) and Maser *et al*. (2002). Plant height was significantly highest at compost application than cow dung. The U.S. Compost Council (2008) stated that the frequency and intensity of irrigation may be reduced because of the drought resistance and efficient water use characteristics of compost. Compost particles are finer and in decomposed form. Due to their fine particle size, water holding capacity is high and the nutrients are in available form. So crop performance was high in compost than cow dung.

3.2. Leaf area

Table 2. Effect of organic manures and rate of Potassium on cowpea leaf area at onset of flowering and harvesting stage

Organic manures	***Rate of Potassium (MOP)***	***Leaf area at flowering (cm^2)***	***Leaf area at harvesting (cm^2)***
Cow dung	*K0 (100%)*	*426.000 ± 1.732[d]*	*672.406 ± 1.149[d]*
	K1 (125%)	*475.000 ± 2.081[c]*	*776.693 ± 0.930[c]*
	K2 (150%)	*552.333 ± 1.855[b]*	*821.350 ± 0.870[b]*
	K3 (175%)	*585.000 ± 1.154[a]*	*889.573 ± 0.297[a]*
Compost	*K0 (100%)*	*503.000 ± 2.081[d]*	*584.086 ± 0.504[d]*
	K1 (125%)	*524.667 ± 2.403[c]*	*596.700 ± 0.351[c]*
	K2 (150%)	*574.333 ± 2.027[b]*	*681.260 ± 0.812[b]*
	K3 (175%)	*584.667 ± 1.201[a]*	*955.426 ± 0.540[a]*
	Organic manure	*$P < 0.05$*	*$P < 0.05$*
	MOP	*$P < 0.05$*	*$P < 0.05$*
	Interaction	*$P < 0.05$*	*$P < 0.05$*

The values are means of replicates ± standard error

Means at the same letter(s) in same column are not significantly different from each other according to the Duncan multiple range test at 5% significant level.

Highest leaf area was observed at K3 and was followed by K2 and the lowest value was observed at K0 combination with organic manures. This may be due to the higher rate of potassium and it induces higher uptake of nitrogen and increase in leaf area due to high maintenance of nitrogen concentration in leaf tissues under sustained supply of potassium ion in soil-plant continuum. (Silberbush & Lips 1991). Sultana *et al*. (2012) reported that increased rate of potassium showed significant effect on number and fresh weight of leaves and combined effect of organic manure and potassium was also statistically significant on the number of leaves and their fresh weight. Barman *et al*. (2013) also reported that combined effect of organic manure and potassium on number of leaves per plant was significant and found that number of leaves was highest at high dose of potassium and organic manure. From the above statements we could state that when number of leaves increased leaf area was also increased.

3.3. Pod numbers per plant

Table. Effect of organic manure and rate of potassium on pod numbers per plant of cowpea

Organic manure	***Rate of Potassium (MOP)***	***Pod number/ plant***
Cow dung	*K0 (100%)*	*3.000 ± 0.0000^{b}*
	K1 (125%)	*3.333 ± 0.3333^{b}*
	K2 (150%)	*4.000 ± 0.5773^{ab}*
	K3 (175%)	*4.667 ± 0.3333^{a}*
Compost	*K0 (100%)*	*3.333 ± 0.3333^{b}*
	K1 (125%)	*3.333 ± 0.3333^{b}*
	K2 (150%)	*4.667 ± 0.3333^{ab}*
	K3 (175%)	*5.000 ± 0.5773^{a}*
	Organic manure	*$P > 0.05$*
	MOP	*$P < 0.05$*
	Interaction	*$P > 0.05$*

The values are means of replicates ± standard error

Means at the same letter(s) in same column are not significantly different from each other according to the Duncan multiple range test at 5% significant level.

Highest number of pods were recorded at K3 and followed by K2. Ali *et al*. (1996) who studied the effect of different potassium levels and reported that the number of pod per plant of mung bean was significantly influenced by potassium application.

Potassium plays an important role in flowering and as well as in seed development. Fan *et al*. (2001). Increasing rate of potassium helps to increase the number of flowers and ultimately increases the yield (Zou *et al*. 2007). From this statements we could state that increasing rate of potassium increases the flower number and finally pod number per plant.

4. CONCLUSION

From the above study it was concluded that highest growth and yield performance were recorded in the combination of compost with 175% recommendation of potassium as MOP at reduced watering interval. Also combinations of 175% recommendation of MOP with compost and cow dung at reduced watering interval were improved all the parameters of cowpea which were taken in this experiment.

5. REFFERENCE

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