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SHORT COMMUNICATION

EFFECT OF FOLIAR APPLICATION OF RED LARGE ONION (*Allium cepa* L.) PEEL SOLUTION ON GROWTH AND YIELD OF COWPEA (*Vigna unguiculata* L. WALP)

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ABSTRACT

Cowpea (*Vigna unguiculata* L. Walp.) is a significant food and grain legume in the semi-arid tropic. Red onion peels are utilized to produce organic potassium rich fertilizer for the cultivation of crops. Hence, this experiment was carried out to study the effect of red large onion (*Allium cepa* L.) peel solution as a foliar application on the growth and yield of cowpea. It was designed in a randomized complete block design with six treatments (20, 40, 60, 80 and 100% onion peel solution and control with water). In this experiment, the red large onion peels (100 g) from kitchen waste were added to one litre of water and then kept at room temperature for 48 hours. Thereafter, the liquid solution was filtered using a 1 mm-sized mesh sieve and filtered solution was considered as 100% onion peel solution. The treatments were applied at two weeks intervals starting from two weeks after planting seeds The results revealed that foliar application of onion peel solutions led to significant (P<0.05) effects on tested parameters over the control. The application of 40% concentration onion peel solution increased the plant height, number of leaves and number of branches per plant, at 9th week after planting and also number of nodules was recorded after harvesting pods. Among the treatments, the application of 100% concentration onion peel solution gave the highest values in many measured yield parameters. There were no significant differences in these parameters between plants applied with 80% and 100% onion peel solutions. Further, significantly (P<0.05) highest yield was obtained in plants treated with 100% onion peel solution (403.64 g/m^2) followed by 80% solution application (342.17 g/m^2) compared to the control treatment (112.41 g/m^2). Therefore, it could conclude that 80% - 100% concentrations of onion peel solution could be used to enhance the seed yield of *Vigna ungiculata* L.

Keywords: Compost, cowpea, foliar application, onion peel solution, yield

INTRODUCTION

Cowpea (*Vigna unguiculata* L. Walp.) is one of the main foods and grain legumes in the semi-arid tropics (Singh 2005). As a legume, cowpea pods contain protein as well as vitamins and minerals from young leaves and pods (Nielsen *et al.* 1997). Cowpea is mainly cultivated in the dry and intermediate zones of Sri Lanka. In crop production, fertilizer is an essential input and in recent years, farmers have widely used inorganic fertilizer, which is considered a significant source of plant nutrients. In agriculture, the usage of excessive inorganic fertilizers leads to environmental and human health problems (Seran 2018; Gayathri and Seran 2020) while the continuous application causes deficiency of secondary macronutrients and micronutrients (Osundare 2004). Unfortunately, quantitative studies that assess the impact of agriculture on environmental quality are minimal (Lichtenberg 2002). Nutrients in the organic manures are slowly released, and they are retained for a longer period in the soil, Ayoola and Makinde 2007).

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Applications of organic manures also promote the soil microbial properties (Belay *et al*. 2001), boost soil fertility, increase water-holding capacity and improve beneficial organisms (Seran 2018). Applying organic materials with inorganic fertilizers gives sustainable high crop yields on a long-term basis (Cai and Qin 2006).

In general, applying foliar fertilizers immediately distributes nutrients to the crop. The application of plant nutrients through the leaves can quickly counter a mineral imbalance and promote the efficiency of the plant nutrients absorbed by roots (Shirani and Seran 2009). Liquid fertilizers can be applied to the crops during vegetative and reproductive stages as foliar sprays (Iqram and Seran 2016). Food waste is also considerably associated with natural resources (Juvan *et al*. 2018). *Allium cepa* (L) is one of the most important consumed vegetables in the human diet, traditionally used in food and medicine. Red onion is considered a high-value cash crop in the dry and intermediate zone, and it has a vital role in the Sri Lankan diet. Onion is rich in carbohydrates, proteins, sodium, potassium and phosphorus (Gomaa 2017). Onion peels contain a potassium concentration of around 234 mg per bulb, the most significant element utilized as fertilizer (Gosavi *et al*. 2020). Benítez *et al*. (2011) reported that onion wastes are good sources of minerals viz., potassium (11.1–15.9 mg/g), calcium (1.8–16.5 mg/g), magnesium (0.6–1.5 mg/g) and others (iron, zinc and manganese). The application of mineral nutrients generally improves the growth, yield and quality of crops (Gosavi *et al*. 2020). Among the mineral nutrients, potassium and magnesium significantly contribute to the process of photosynthesis and the subsequent long-distance transport of photoassimilates (Tränknera *et al*. 2018). Further, potassium is an essential mineral for cell growth which is a significant process for the function and development of plants (Hepler *et al*. 2001). Therefore, this experiment was done to study the effect of red large onion (*Allium cepa* L.) peel solution as a foliar application on the growth and yield of *Vigna unguicuata* L. Walp. and to find out the optimum concentration of red onion (*Allium cepa* L.) peel solution for the cultivation of *Vigna unguicuata* L. Walp.

MATERIALS AND METHODS

The effect of foliar application of red onion peel solutions on growth and yield of cowpea cv Dhawala were studied in a pot experiment at the home garden, Mailapitiya, Kandy, Sri Lanka, which is located at an elevation of 465 m above the mean sea level in the Central Province of Sri Lanka from May to September 2021. The experimental site's geographical coordinates are latitude of 70 17’26.2” North, and longitude of 800 38’01.0” East. This area falls under the upcountry zone of the main agro-climatic zones of Sri Lanka and also comes under the wet zone and WU3 agroecological region in Sri Lanka. The reddish-brown lateritic soil is the dominant soil of the Kandy district (Moormakn and Panabokk 1961). This study was carried out using Randomized Complete Block Design (RCBD) with six treatments and six replicates. Treatments included 100% water (T1: Control) and different concentrations of onion peel solution (T2-T6: 20%, 40%, 60%, 80% and 100% solution respectively) applied at two weeks intervals.

For the experiment, the red large onion peels were collected from kitchen waste at the household level every day. After removing the unwanted materials, 100 g of onion peels were taken. Subsequently, it was placed in a plastic container, and one litre of water was added. The lid was then covered on top and left at room temperature for 48 hours, as described by Chiew *et al*. (2014). After that, the liquid solution was filtered using a 1 mm-sized mesh sieve and kept separately for being used in this experiment as a foliar spray.

Cowpea was grown in polybags (30 cm in length and 15 cm in diameter). Each polybag was filled with topsoil and sand at 1:1 (v/v) mixture with 22.5 g (5 t/ha) of compost (0.46%N, 0.43% P_2O_5, and 0.51% K_2O) remaining 5 cm gap from the top of the bag. Two seeds of the cowpea variety, Dhawala were planted in each polybag at a depth of 1-2 cm and covered with soil. After two weeks of seeding, thinning out was practised to

maintain one plant per polybag.

As per the recommendation of the Department of Agriculture, Sri Lanka, 0.157 g urea and 0.45 g Triple superphosphate were applied as basal, while 0.135 g urea was applied as a top dressing for each polybag. Onion peel solutions were sprayed four times at two-week intervals, starting from two weeks after planting cowpea seeds. At each application, 50 ml of solution was sprayed on each plant, and distilled water was used as the control treatment. Irrigation was done twice a day in the early morning at about 7 am and late evening at about 5 pm from planting until germination then decreased to once a day until pod development and finally reduced to once every two days in the evening following pod formation by using a watering can. Hand weeding was carried out at weekly intervals to remove weeds until the final harvest.

Data collection was done starting from the 3rd week after planting at two weeks intervals until harvesting. Plant height, number of leaves per plant, number of branches per plant, days to 50% and 100% flowering and number of flowers per plant were measured. Harvesting was done at the harvesting stage (64 days after planting). The total number of pods per plant and also pod length (cm) were recorded at each picking. Further, the number of seeds per pod, and 100 seed weight were taken after harvesting. Subsequently, seed yield was calculated. The number of nodules per plant was recorded after uprooting the plants 86 days after planting. The collected data were statistically analyzed using Statistical software (SAS), and treatment means were compared using Tukey's HSD test at 5% significant level.

RESULTS AND DISCUSSION

The results showed that there was a significant difference in plant height among the treatments every week after planting (WAP) (Table 1). According to the literature survey, onion peel has considerably more potassium than other mineral nutrients viz. calcium, magnesium, iron, zinc and manganese ((Benítez *et al.* 2011), and potassium is necessary for cell growth (Helper *et al.* 2001) which may be the reason for the increment of plant height. Plant height is a significant factor in a plant's ability to compete for light (Kunstler *et al*. 2016).

The effect of different concentrations of onion peel solution application was not significantly different ($P>0.05$) in the number of branches per plant at different weeks (Figure 1). At the 9th week after seeding, onion peel solution application significantly influenced ($P<0.01$) the number of leaves per plant however, among the treatments there was no significant difference (Table 2). Saravaiya *et al*. (2014) reported that the number of branches per plant increases due to the foliar application of micronutrients in tomato plants. Sharma *et al*. (1996) stated that applying liquid fertilizers containing most macro and micronutrients increases the number of branches per plant than the control treatment in chilli plants. In the present study, more than 22 leaves per

Table 1: Effects of different concentrations of onion peel solution on plant height of cowpea at different weeks.

Treatments	Plant height (cm) at different weeks			
	3rd week	5th week	7th week	9th week
T1	18.56±0.53b	32.88±0.87c	46.85±1.21c	65.93±1.17c
T2	20.18±0.49ab	36.52±0.97b	53.63±1.22b	76.26±1.78b
T3	21.46±0.42a	40.28±0.64a	60.08±0.86a	83.58±1.16a
T4	19.10±0.66ab	38.48±0.68ab	55.93±1.52ab	81.4±1.09ab
T5	19.46±0.64ab	39.12±0.87ab	57.63±0.74ab	80.20±1.54ab
T6	19.93±0.58ab	38.68±0.89ab	58.86±0.67a	80.96±1.22ab
F test	P<0.05	P<0.01	P<0.001	P<0.001

Values represent the mean ± stand error of six replicates. Mean values in a column having dissimilar letters indicate significant differences at a 5% level of significance according to Tukey's HSD Test.

plant were recorded in plants treated with onion peel solution as liquid fertilizer which affected the number of branches per plant and number of leaves per plant. It may be due to the additional nutrients in foliar fertilizer, which influences in vegetative growth of the plant. Potassium is the critical factor in the growth of cowpea (Priyadharshini and Seran 2009). Leaves in the plant are responsible for photosynthesis. Thus, the number of leaves per plant is a relatively important growth parameter of a plant (Hikosaka 2010).

Days for 50% and 100% flowering of cowpea were significantly varied ($P<0.05$) between the treatments due to the onion peel solution application (Figure 2). To attain 50% and 100 % flowering, 38 days and 44 days were taken by T6 (100% onion solution), respectively. In T1 (control treatment), 46 and 56 days were taken for 50% and 100% flowering, respectively. Sharifi *et al*. (2018) noted that the days taken for flowering are persuaded by foliar application of water-soluble fertilizer. Figure 3 demonstrates the effects of different concentrations of onion peel solution on the number of flowers on cowpea plants in the 7th week and 9th week. In cowpea plants, flowering started in the 7th week after seeding. According to the results of this study, the foliar application of onion peel solution 80% and 100% at two weeks intervals significantly ($P<0.05$) increased the number of flowers in T5 and T6 compared to T1. Further, it was noted that there was no significant variation in the number of flowers between T4, T5 and

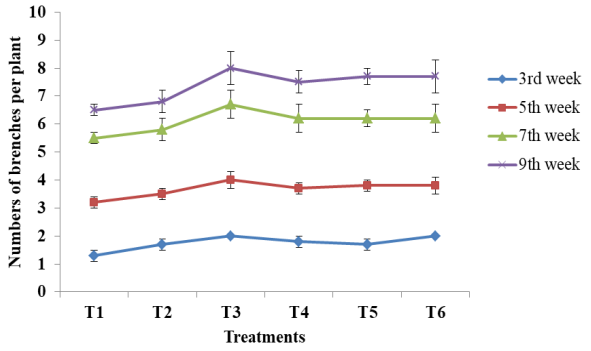

Figure 1: Effects of different concentrations of onion peel solution on the number of branches per plant of cowpea at two weeks intervals.

Table 2: Effects of different concentrations of onion peel solution on the number of leaves per plant of cowpea at different weeks.

Treatments	Number of leaves per plant at different weeks			
	3rd week	5th week	7th week	9th week
T1	5.8± 0.7	10.8± 0.3	17.8± 0.6	20.0± 1.2b
T2	7.0± 0.5	12.2± 0.7	19.2± 1.2	22.8± 1.6ab
T3	7.8± 0.2	13.7± 0.8	21.7± 1.4	26.7± 1.7a
T4	7.0± 0.5	12.7± 0.5	20.2± 1.4	26.0± 0.8a
T5	6.7± 0.7	12.8± 0.5	20.0± 0.9	24.8± 0.8ab
T6	7.3± 0.3	13.0± 0.9	20.0± 1.4	25.5± 1.3a
F test	P>0.05	P>0.05	P>0.05	P<0.01

Values represent the mean ± stand error of six replicates. Mean values in a column having dissimilar letters indicate significant differences at a 5% level of significance according to Tukey's HSD Test.

T6. The mean number of flowers increased with the application rate of the onion peel solution in this experiment. According to Shah *et al.* (2014), different levels of zinc foliar application had a considerable effect on the number of flowers per plant of the marigold plant.

As shown in Table 3, the foliar application of onion peel solution significantly influenced ($P<0.001$) the increased total number of harvested pods per plant and the number of seeds per pod. Compared to the control (T1), 40-100% foliar application (T3-T6) exhibited significantly high pods per plant. The average numbers of seeds per pod were 10.3 in T1 and 14.9 in T6. The findings were supported by Chandrasekhar and Bangarusamy (2003), who reported that potassium nutrition increased pods per cluster in mustard and Jyothi *et al.* (2013) who reported that the number of seeds per fruit was remarkably influenced by foliar application of water-soluble fertilizer.

The data presented in Table 3 shows that the onion peel solution in different concentrations played a significant role in average pod length, number of seeds per pod and the number of nodules per plant. However, there wasn't a significant difference in these parameters from T3 to T6. These variations may be due to the positive effect of peel solution as a liquid fertilizer. Zedan (2011) stated that the character of pod length hsignificant variation between the treatments of control without adding potassium fertilizer.

Further, the number of nodules in all varieties of cowpea was directly proportional to rates of P fertilizer application (Karikari *et al*. 2015). Nodulation in legume plants is essential to fix nitrogen by rhizobial bacteria. As a result, the nitrogen fertilizer required for the plant is reduced. The seed weight was recorded to assume the seed production with the effect of onion peel application. Significantly higer 100 seed weight and seed yield per m2 was observed in T5 and T6 (Table 4). Sharifi *et al.* (2018) reported that the data on 100 seed weights for each picking is influenced by

Table 3: Effects of different concentrations of onion peel solution on the total number of pods per plant, pod length and number of seeds per plant and number of nodules per plant.

Treatments	Total number of pods per plant	Pod length (cm)	Number of seeds per pod	Number of nod-ules per plant
T1	3.7±0.3c	12.35±0.74b	10.3±0.7c	3.7±0.8c
T2	4.5±0.2bc	14.13±0.66ab	11.9±0.7bc	6.0±0.4bc
T3	6.0±0.5abc	14.83±0.31ab	12.6±0.4abc	9.5±1.3a
T4	6.8±0.8ab	15.63±0.63a	13.4±0.8ab	6.5±1.1abc
T5	8.3±0.8a	14.50±0.85ab	13.8±0.4ab	5.5±1.3bc
T6	8.0±0.6a	16.55±0.43a	14.9±0.5a	8.3±1.5ab
F test	P<0.001	P<0.01	P<0.001	P<0.05

Values represent the mean ± stand error of six replicates. Mean values in a column having dissimilar letters indicate significant differences at a 5% level of significance according to Tukey's HSD Test.

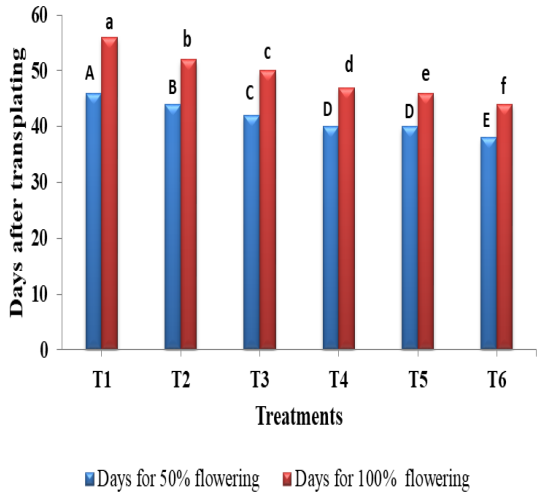

Figure 2: Effects of different concentrations of onion peel solution in days taken for 50% and 100% flowering of cowpea plant.
Mean values in a bar having dissimilar letters indicate significant differences for each parameter at a 5% level of significance according to Tukey's HSD Test.

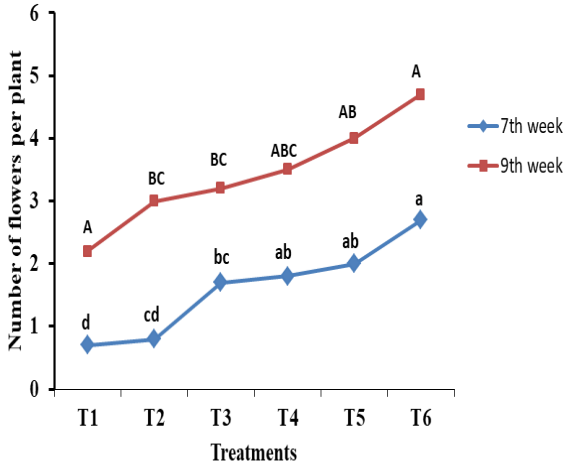

Figure 3. Effects of different concentrations of onion peel solution on the number of flowers per plant of cowpea at two weeks intervals.
Mean values in a line having dissimilar letters indicate significant differences for each parameter at a 5% level of significance according to Tukey's HSD Test.

Table 4: Effects of different concentrations of onion peel solution on 100 seed weight and seed yield of cowpea plant.

Treat-ments	100 seed weight (g)	Seed yield (g) per m^2
T1	9.90±0.71d	112.41±6.97d
T2	10.88±0.12cd	159.54±6.11cd
T3	11.14±0.35cd	210.31±7.37bc
T4	12.34±0.51bc	263.35±10.96b
T5	13.61±0.65ab	345.17±26.99a
T6	15.10±0.47a	403.64±19.43a
F test	P<0.001	P<0.001

Values represent the mean ± stand error of six replicates. Mean values in a column having dissimilar letters indicate significant differences at a 5% level of significance according to Tukey's HSD Test.

foliar application of water-soluble fertilizer. The present result reveals that 100% (v/v) concentration of onion peel solution influenced the increment of 100 seed weight of cowpea plant.

Chatterjee and Bandyopadhyay (2017) stated that the unavailability of important micronutrients is a major constraint for cowpea growth and pod yield under acid soil conditions. Increasing application rates of potassium increased the marketable yield of tomatoes (Harneet *et al.* 2003). Ramezani and Shekafandeh (2011) stated that potassium could increase fruit quality by improving the formation and translocation of carbohydrates from the shoot to storage organs (pods) and carbohydrate enzymes. Further, Suitable organic manure incorporated into the soil increases the soil's physical and chemical properties consequently; it gives direction to obtaining high fruit yield (Agbede *et al.* 2008). Seran and Imthiyas (2016) also stated that the application of compost to soil increases organic matter content and provides favourable soil conditions for higher crop yield.

CONCLUSIONS

The foliar application of red large onion peel solution had a significant (P<0.05) effect on the growth and seed yield of *Vigna unguiculata* L. compared to the control treatment. The 40-100% onion peel solution application increased most of the growth parameters than the other treatments. Among the treatments, the organic application of 80% -100% onion peel solutions (T5-T6 respectively) gave the highest values in many measured yield parameters compared to the other treatments. Therefore, eco-friendly, low -cost foliar application of red large onion peel solution at the rate of 80%-100% concentration at two-week intervals could be recommended for cowpea cultivation to increase the yield.

AUTHOR CONTRIBUTION

GAND performed the experiments. GAND and THS analyzed the data. GAND wrote the paper with input from co-author.

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