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GROWTH OF CARROTS (DAUCUS CAROTA VARI. KURODA) SUPPLIED WITH DIFFERENT LEVELS OF KAPPAPHYCUS ALVAREZII DRIPPINGS

DELIVERED THROUGH SUBSURFACE DRIP IRRIGATION UNDER GRENNHOUSE STRUCTURE

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ABSTRACT

The study was conducted at RTC-Korea-Philippines Vocational Training Center Davao, Buhisan, Tibungco, Davao City from March to May 2017 to determine the growth performance of carrots in terms of number of leaves and leaf stalks as supplied with different levels of Kappaphycus alvarezii drippings at 10 ml, 20 ml, and 30 ml per liter of water.

Data were statistically analyzed through Randomized Complete Block Design (RCBD) with five (5) treatments replicated three (3) times. The treatments include pure water (T1), a nutrient solution of 10 ml of Kappaphycus alvarezii drippings per liter of water (T2), a 20 ml Kappaphycus alvarezii drippings per liter of water (T3), a 40 ml Kappaphycus alvarezii drippings per liter of water (T4), and a concentration of water and commercial organic foliar fertilizer (T5).

Results showed that the application of Kappaphycus alvarezii drippings through subsurface drip irrigation improved the vegetative growth of carrot in terms of the leaf stalk and leaf count at 30, 37, and 45 days after sowing, under greenhouse structure.

Keyword: Vegetative growth, Carrot, Kappahycus alvarezii drippings, subsurface drip irrigation, fertigation, greenhouse structure

1. INTRODUCTION

Carrot (*Daucus carota L.*) is one of the most important root vegetable plants in the world with production expanding rapidly in Asia which is used as source of beta-carotene which the body converts to Vitamin A, eaten both raw and cooked, in sweet savory dishes, major ingredient in the food processing industry, a significant constituent of cosmetic product and its image has long been used to symbolize healthy eating (Stolarczyk and Janick, 2011). In the Philippines, the major production areas of carrot were Benguet, Mountain province, Ifugao, Nueva Vizcaya, Cebu, Negros Oriental, Bukidnon, and Davao del Sur which PCARRD-DOST identified carrot upon recognizing its importance in the industry as a priority crop under the National Vegetable Research and Development Program (PCARRD-DOST, 2003).

Kappaphycus drippings or KD foliar fertilizer which is developed by the Southern Philippines Agri-business and Marine and Aquatic School of Technology (SPAMAST) is derived from the drippings of *Kappaphycus alvarezii*, a specie of red algae (Philippine Star, 2016. It contains microelements and plant growth regulators such as cytokinin and used as a foliar spray, application to soil and for soaking of seeds before sowing (Zodape, 2001). Many related studies have resulted to positive outcomes such as improved yield with application of 15% *Kappaphycus alvarezii* seaweed extract (Rathore *et al.*, 2008), increased yield at 1.0% concentration of *K. alvarezii* extract (Zodape *et al.*, 2009), improved seed germination and growth potential of paddy, groundnut and chilli (Babu and Renagsamy, 2012), and increased in yield and improved quality on 27 vegetable crops including carrots with 5% concentration of *K. alvarezii* as bio-stimulant (Karthikeyan and Shanmugan, 2016).

Greenhouse, as defined in PAES 415 (2001), is a structure that provides reliable enclosure within which an environment favorable to plant growth can be attained, thus providing favorable temperatures for plant growth, reducing sunlight and damage caused by heavy rain (Caestilla and Baeza, 2013).

The use of subsurface drip irrigation system for irrigation minimizes the loss of moisture in the soil due to evaporation, crusting, ponding of water, and potential surface runoff because it is buried down in the soil (Reich *et al.*, 2001). These effects of surface irrigation water such as crusting and ponding of water are detrimental to carrot growth especially during early growth stages (STARKE AYRES, 2014).

The optimum production of carrot inside a greenhouse structure can be reach through the application of appropriate amounts of nutrients needed by plants during growth stage. This can be done through proper delivery of nutrient solutions which can be dissolve directly or inject it into the irrigation water that can be delivered through irrigation system. The researcher determined the effectiveness of the application of *Kappaphycus* drippings through subsurface drip irrigation improved the vegetative growth performance of carrot grown inside the greenhouse structure. This study was used to support the vegetable production and organic farming in the country in improving the growth.

2.MATERIALS AND METHODS

The study was conducted at RTC-Korea-Philippines Vocational Training Center Dvao, Buhisan, Tibungco, Davao City under greenhouse structure from March to May 2017. The study was conducted using Randomized Complete Block Design (RCBD) with five treatments replicated three (3) times. The treatments were as follows: (T_1) pure water, (T_2) 10 mL *Kappaphycus alvarezii* drippings/liter of water, (T_3) 20 mL *Kappahycus alvarezii* drippings/liter of water, (T_4) 30 mL *Kappaphycus alvarezii* drippings/liter of water and (T_5) treated with commercial organic foliar fertilizer. The greenhouse structure has dimension of 6 meters by 35 meters and raised of up to a height of 3.4 meters. The greenhouse structure used net as its cover on its sides and plastic cover on its upper portion.

The experimental area was prepared by digging the soil of up to 12 inches in depth into a fine tilth using a shovel to break up any large lumps. Moreover, this was done to make sure that the soil was free of rocks. All weeds were removed inside the greenhouse. Removing of weeds was done by hand-weeding. The experimental plot having a dimension of 17 meters by 1.4 meters was divided into five equal parts. Each part had a dimension of 3.4 meters by 1.4 meters. Raised beds were formed in each plot. Shovel was used to till the soil and form into raised beds. There were three (3) raised beds used per treatment that represents as replications. The raised beds have a height of 20 cm and 40 cm wide and 30 cm spacing was provided between raised beds.

The subsurface drip irrigation composed of dripperlines, emitters andplastic containers. The dripperlines was buried below the raised beds at a depth of 30 cm. The design of the emitter spacing was 30 cm apart. The water was supplied through micro discharge from emitters on drip tubes at a rate of 2 liters per hour. The design spacing of the lateral lines was 70 cm apart. There were three (3) laterals per treatment. There were 11 drippers assigned per laterals. Depth of placement of laterals was the same on the five (5) treatments. The water used as source was from Dumoy's Water District. The water used in the five treatments was the same. The water was delivered to the plants based on the carrot water requirements of 25 mm every 7 days. The plot constituting three (3) raised beds had a dimension of 3.4 meters by 1.4 meters. The volume of water for the irrigation in terms of liter per day was calculated through the plot area are multiplied by the crop water requirement which is 25 mm. this resulted to 119 liters per 7 days. The duration of the irrigation was based on the discharge capacity of the drippers which was 2 liters per hour. To meet the crop water requirement of carrot, the duration of the irrigation 3.6 hours per week. This was done simultaneously on the five treatments. There were five (5) different set-ups of this system which constituted the different levels of *Kappaphycus alvarezii* drippings and commercial foliar fertilizer.

The *Kappaphycus alvarezii* drippings was dissolved on the irrigation water in the plastic container. Each container had a nutrient solution of 10 ml, 20 ml, and 30 ml *Kappaphycus alvarezii* drippings per liter of water and one plastic container having the commercial organic foliar fertilizer solution. The plastic container has a volume capacity of 50 liters. The total volume of *Kappaphycus alvarezii* drippings at 10 ml, 20 ml, and 30 ml concentration that was mixed to the irrigation water was calculated using the ratio and proportion. At the same time, the nutrient solution containing the commercial organic foliar fertilizer had its concentration based on the prescribed recommendation by its manufacturer which can be found on its label.

Carrot (*Daucus carota L.*) seeds were sown directly on the raised beds manually. Three seeds were sown per hill to avoid replanting and for assurance of growth. Each hill was spaced 2 inches in rows. The seeds were planted ¼ inch depth, covered with thin layer of soil, and then pressed gently. Initially, seeds were watered using sprinkling can after sowing. Carrots were thinned to a final spacing of 3 inches. Thinning was done when the tops of the carrot were 2 inches high to provide enough space for the root growth. It was done by gently removing the plants and transplanted on the spaces where germination failed to occur. Hilling up was performed after thinning. Shallow cultivation was done when the first true leaves appear from the ground to avoid root injury. Weeds were removed regularly by hand-weeding. This was done to suppress the growth of weeds and provide a better aeration for the growing of carrot plants.

The general crop water requirement of carrot is 900 mm of water per crop cycle (STARKE AYRES, 2014). Fertigation on carrots were carried out using subsurface drip irrigation consistent in giving fixed amount of water, 25 mm every 7 days from planting until 45 days (Nagaz, *et al.*, 2012). To meet the crop water requirement of carrots, fertigation was done 3.6 hours per week. The nutrient solution of *Kappaphycus* drippings at 10 ml, 20 ml, and 30 ml concentration per liter of water was diluted directly into the container containing the irrigation water. There were different plastic containers for each nutrient solution which was delivered on the carrot through subsurface drip irrigation. The fertigation was done together with the irrigation water on the same time schedule, since *Kappaphycus* drippings was dissolved directly on the irrigation water.

The inside temperature of the greenhouse was measured using digital thermos-hygrometer with a corresponding relative humidity. The monitoring of the temperatures was done thrice a day, during 6 o'clock to 7 o'clock in the morning, 11 o'clock to 12' clock in noon and 5 o'clock to 6'clock in the afternoon. The average internal temperature and relative humidity were calculated.

The number of leaves and leaf stalks of carrots were counted manually per replication per treatment. This was done after 30 days, 37 days, and 45 days after sowing. The data on the number of leaves and leaf stalks of carrot at harvest were used initially to determine the growth of performance of carrot as supplied with different levels of *Kappaphycus alvarezii* drippings under greenhouse structure.

The internal temperature was measured using a digital thermos-hygrometer. The average temperature of the greenhouse structure was then calculated based from morning, noon, and afternoon temperatures recorded. Relative humidity at the same time was measured through digital thermos-hygrometer. The average relative was then calculated based on the morning, noon, and afternoon relative humidity readings which were recorded.

3.RESULTS AND DISCUSSION

The study collected the data which comprises from the early emergence stage up to vegetative stage of carrots. Data observed were from sowing up to 45 days. The number of leaf stalks was counted at 30, 37, and 45 days after sowing. The number of leaf stalks was used to determine the initial growth performance of carrot as supplied with different levels of *Kappaphycus alvarezii* drippings under greenhouse structure.

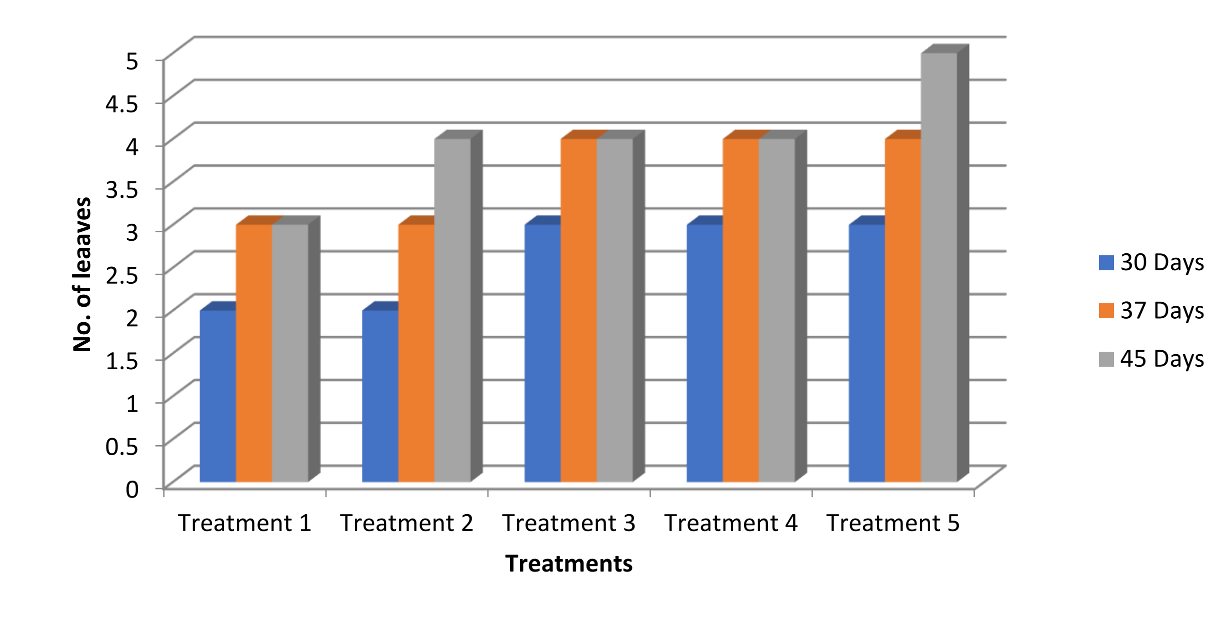

Figure 1. Variations of Mean Number of Leaf Stalks at 30, 37 and 45 Days after Sowing.

Based on the figure, during the 45-day monitoring of leaf stalk count, Treatment 5 produced more number of leaf stalks as compared with other treatments. Moreover, the treatments which were treated with the 10 ml, 20 ml, and 30 ml *Kappaphycus* drippings per liter of water have produced more leaves compared with Treatment 1 which was irrigated with pure water.

As specified, during the 45-day monitoring for the leaf stalk count of carrot after sowing, the mean number of leaf count of Treatment 5 was 5 leaf stalks greater than the mean number of leaf stalks in Treatment 4, 3, 2 and 1 which were 4, 4, 4, and 3 leaf stalks, respectively. As for the treatments, which were treated with *Kappaphycus alvarezii* drippings, it showed greater mean number of leaf stalk compared to Treatment 1 which was irrigated with pure water. This means that commercial organic foliar fertilizer had produced more leaf stalk as compared to application of *Kappaphycus alvarezii* drippings with different levels. In case of application of the application of *Kappaphycus* drippings at different levels compared to irrigation with pure water, it produced more leaf stalk. This means that the effect of *Kappaphycus alvarezii* drippings may be comparative to the effect of commercial organic foliar fertilizer.

Table 1. Mean number of leaf stalks of Carrot at 30, 37 and 45 days after sowing as supplied with different levels of *Kappaphycus* drippings under greenhouse structure. RTC-Korea-Philippines Vocational Training Center Davao, Buhisan, Tibungco, Davao City. March –May 2017.

Treatment	No. of Days from Sowing		
	30**	37^{ns}	45^{ns}
T_1 – pure water	2^b	3	3^b
T_2 – 10 ml KD/liter of water	2^b	3	4^b
T_3 - 20 ml KD/liter of water	3^a	4	4^a

T_4 - 30 ml KD/liter of water	3^a	4	4^a
T_5 – treated with commercial foliar fertilizer	3^a	4	5^a
CV=	9.96%	-	9.60%

**= highly significant means having the same letter superscript was not significantly different from each other at 1% level of significance

Data presented in Table 1 shows that the application of *Kappaphycus alvarezii* drippings affected greatly the vegetative growth of carrot. It is clear that the application of *Kappaphycus alvarezii* drippings was related to improve growth performance compared to application of pure irrigation water same as to the application of commercial organic foliar fertilizer. In terms of leaf stalk count, Treatment 5 which was treated with commercial foliar fertilizer had greatly affected the number of leaf stalks as compared to the rest of the treatments based on the increment weeks of monitoring. The capability of *Kappaphycus alvarezii* drippings to improve vegetative growth performance could be attributed to the nutrient composition of *Kappaphycus alvarezii* drippings namely nitrogen, phosphorus and potassium which nitrogen had greater percentage (Zodape *et al.*, 2009). The high concentration of nitrogen as reported by Hokins and Hunter (1973) as cited by Elhindi *et al.* (2015) leads to increase in the number of leaf cells and cell size of the leaf resulting to increase in leaf

production. On the other hand, carrots require relatively low nitrogen. High rates of nitrogen should be avoided, as this stimulates leaf growth at the expense of root development and yield, and also delays harvesting (goo.gl/Cv6wqk). This means that it may cause fast growth on leaf count at the same time slow the growth of carrot roots.

The effect of delivery of fertilizer through subsurface drip irrigation, it might also improve the growth of carrot in terms of vegetative growth as Treatment 1 showed. Furthermore, subsurface drip irrigation improved the water and fertilizer used, this may be attributed to the maintenance of the soil moisture content in the root zone (Sinobas and Rodriguez, 2012). Moreover, subsurface drip irrigation provides more advantage compared to the other form of irrigation system in terms of water use efficiency (Lamm, 2002).

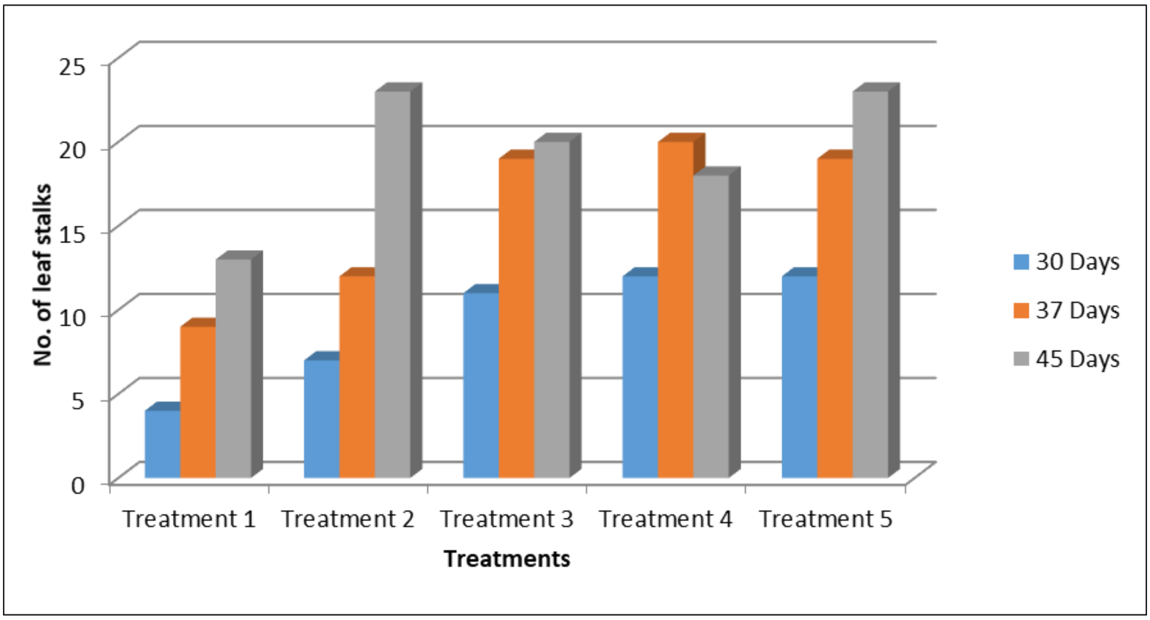

Figure 2. Variation of leaf count of carrot at 30, 37, and 45 days after sowing.

Based on Figure 2, during the 45-day monitoring of leaf count, Treatment 5 produced same number of leaf count with Treatment 2. This means that the effect of *Kappaphycus alvarezii* drippings was comparative to commercial organic foliar fertilizer. The variations of internal temperature readings as well as the corresponding relative humidity may affect also the number of leaf count at 30, 37, and 45 days after sowing in the tretaments. Moreover, insect attacks may be attributed to the consistent on the leaf count on T_3 and T_4.

Statistical analysis revealed that the application of *Kappaphycus alvarezii* affect significantly the leaf count of the plant. The mean numbers of the leaf count were shown in Table 2 which also shown which treatment means had a significant ($p<0.01$).

Table 6. Average number of leaves of Carrot at 30, 37 and 45 days after sowing as supplied with different levels of *Kappaphycus* drippings under greenhouse structure. RTC-Korea-Philippines Vocational Training Center Davao, Buhisan, Tibungco, Davao City. March –May 2017.

Treatment	No. of Days from Sowing		
	30**	37**	45**
T_1 – pure water	4^c	9^c	13^b
T_2 – 10 ml KD/liter of water	7^b	12^b	23^a
T_3 - 20 ml KD/liter of water	11^a	19^a	20^a
T_4 - 30 ml KD/liter of water	12^a	20^a	18^a
T_5 – treated with commercial foliar fertilizer	12^a	19^a	23^a
CV=	9.72%	5.42%	14.18%

**= highly significant means having the same letter superscript was not significantly different from each other at 1% level of significance

During the 30-day monitoring for the leaf count of the carrot, it resulted that Treatment 4 and Treatment 5 produced more number of leaves. On the other hand, after 45-day monitoring, Treatment 2's mean number of leaf count had produced more leaves as compared to the rest of the treatment which was 11 greater than the rest of the treatments.

4.CONCLUSION

The result of the study indicated that the vegetative growth of carrot in terms of leaf stalk and leaf count was enhanced by the application of *Kappaphycus alvarezii* drippings through subsurface drip irrigation. Higher application rate of *kappaphycus alvarezii* drippings had resulted to increased number of leaf stalks and leaves.

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