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Vegetative growth and yield of two watermelon varieties (*Citrullus lanatus*) as influenced by different organic fertilizers

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Abstract

The demand for watermelon for consumption in a fresh form as a source of minerals and vitamins is on the increase. Consequently, any agronomic approach to promoting the productivity and quality of watermelon is a technique that needs to be studied. Thus, an experiment was conducted at Universiti Malaysia Terengganu's research farm to compare the impact of various types of organic fertilizer's (cow manure, sheep manure, poultry manure, goat manure, fish waste, vermicompost, and dolomite) on the growth and yield of two watermelon varieties. A total of sixty-four (64) experimental pots were arranged in a CRD layout and in factorial design of which eight organic fertilizers were used as main factors, and two varieties (V) of watermelon as sub-factors, which was replicated four times. Results of this study showed that the New Dragon variety treated with poultry fertilizer produced significantly higher results in vine length at 4 WAP (79.84 cm), the number of leaves (26.0), LAI (0.77), chlorophyll content at 6 and 8 WAP (60.1 and 66.6 SPAD respectively), days to 50% flowering (20.0 days) and weight of fruits (15.2 t/Ha). Moreso, the seaweed-extract treated New Dragon watermelon variety produced a significantly higher number of female flowers (3.75). Summarily, the New Dragon variety (red-fleshed) recorded higher results for both growth and yield characteristics than the Golden Delight (yellow-fleshed) variety of watermelon. Correlation analysis between morphological and yield parameters showed that yield parameters positively correlated with growth and development. It is recommended that the New Dragon variety of watermelon treated with poultry manure gives the best results.

Keywords: New Dragon, Golden Delight, watermelon, growth, yield, organic fertilizers.
Abbreviations: CRD_Completely randomized design; LAI_Leaf area index; SPAD_Soil plant analysis development; t Ha^{-1}_Tonnes per hectare; FAO_Food and agriculture organization; WAP_Weeks after planting; $CaCO_3$_Calcium carbonate; HNO_3_Hydrogen nitrate; $HClO_4$_Perchloric acid; AFW_Average fruit weight; NS_Not significant

Introduction

Watermelon is a valuable crop because it has many nutritional and economic benefits (Schaffer and Paris, 2016). The crop has been cultivated for decades in the tropics and is well-known in many parts of the world. Watermelon is a good source of water, and it is a thirst quencher that may also reduce the inflammation that contributes to conditions like asthma, atherosclerosis, diabetes, colon cancer, arthritis, and an excellent diuretic (Nthiga et al., 2014). Watermelons play a very important role in Africa as they are used to quench thirst when there is a water shortage (Sodeke 2005). Watermelon seeds are of cosmetic and nutritional importance that contains B2 vitamins, minerals, riboflavin, fat, carbohydrate, and protein (Naz et al., 2014). Their antibacterial effects are known against several common pathogens. The use of animal source manures significantly enhances the yields of the Auldrey watermelon cultivar (Massri and Labban, 2014). Organic fertilizer amendment is part of a new soil fertility management strategy (Eifediyi et al., 2018). The use of organic fertilizers has shown some positive results and also prevents any attack from soil micro-organisms that may be harmful to plants (Massri and Labban, 2014). It is also affirmed that organic matters amendment significantly affects crop growth and development as it is a source of minerals and important nutrients which are capable of releasing and aids in binding the nutrient in soils together (Azeez and Van Averbeke, 2010). The trend of organic fertilizer utilisation nowadays is dramatically increased, especially in improving soil fertility and crop production. The manuring in the tropics is more important than the temperate region due to excessive weathering and leaching. The tropical soil becomes seriously impoverished in plant nutrients, and proper manuring can only play a vital role in crop improvement. Soil amendments using organic and inorganic nitrogen (N) sources have been reported to improve soil conditions and enhance plant growth through replenishment of soil N (Audi et al., 2013). Increased usage of inorganic fertilizers in crop production poses health risks as

well as environmental issues such as contamination of the air, water, and soil. Chemical fertilizers use has a negative impact on soil texture and structure, as well as lowering soil organic matter and inhibiting soil microbial activity owing to toxicity. Organic manure, on the other hand, increases the texture, structure, hummus, color, aeration, water holding capacity, and microbiological activity of the soil. The use of synthetic fertilizers on farms lands can result in serious nutrient imbalance, soil degradation, increased soil acidity, and finally bringing about low yield. However, the use of organic fertilizers can aid in protecting the soil from these hazards and adverse effects. Despite of the application of organic fertilizers by many vegetable farmers, 1,087.59 million tonnes of vegetables were produced in the world in 2015 (Gennari et al., 2015). This is not sufficient to solve the problem of the insufficient nutritional gap to meet the needs of the population. The use of organic fertilizer is preferred because of its soil conservation property and its eco-friendliness over inorganic fertilizer. This source of fertilizer is mostly favored by vegetable farmers to provide nutrients for their vegetables to improve growth and yield (Seufert et al., 2012). Watermelon crop yields in tropical rainforest regions are typically low. This is due to several variables, the most important of which is widespread soil nutrient deficiency, particularly N, phosphorus (P), and potassium (K). Plant micronutrient inefficiency also occurs on a micro level. Watermelon productivity and profitability are both harmed by a deficiency of soil N. N is a highly mobile element that is readily lost in the soil due to leaching, erosion, and rapid mineralization. As a result, combining efficient organic manure usage with other improved cultural practices can be one of the most effective ways of improving production and output (Emeghara et al., 2020). To achieve a high yield of watermelon, the soil's nutrient status must be improved to suit the crop's needs while also maintaining the soil's fertility. Boosting the soil nutrient content with organic material such as poultry dung is one strategy to improve soil nutrient status (Dauda et al., 2005). Watermelon is a heavy feeder of N and therefore required a liberal application of slow-releasing organic source nitrogenous fertilizer up until the flowering stage (Emeghara et al., 2020). It is also essential to determine the efficacy of organic fertilizer as it directly impacts the yield of watermelon crops and helps in the conservation of the soil. Because of the foregoing, there is a need to determine which organic manure is the best for watermelon production. Hence, the purpose of this study was to examine the effect of different organic fertilizers on the growth, development, and yield of two watermelon varieties.

Results and discussion

The results and discussions were focused on results that showed significant interactions between watermelon varieties and organic fertilizers. There was an interaction effect between varieties and organic fertilizers on vine length, number of branches, number of leaves, leaf area index, chlorophyll content, days to 50% flowering, number of flowers, and fruit weight.

Effects of interaction between varieties and organic fertilizers on vine length

Figure 1A reports the interaction between variety and organic fertilizers on vine length measurement at 4 WAP. New Dragon variety treated with Poultry Manure produced the highest significant vine length with a mean value at 79.84 cm, which does not vary significantly from the Golden Delight variety in the Control plot at 71.31 cm. However, the New Dragon variety treated with Poultry Manure does not differ statistically from most of the treatments. The control in both varieties produces the least significant vine length at $P<0.05$. The height of a plant is a vital growth character that is directly linked with the productive potential of the plant in terms of yield (Adeyeye et al., 2016). In this study, the vine length of watermelon varieties increased as the growing period was increased. The New dragon variety at ($P<0.05$) had the highest vine length compared with the other variety throughout the sampling period. This is in accordance with a study conducted by Nwokwu (2015) that red varieties of watermelon give longer vine length as compared to other varieties. The Vine length was significantly higher in Poultry manure, and poultry fertilizer is rich in N (Efthimiadou et al., 2010).

Effects of interaction between varieties and organic fertilizers on number of leaves

Results for interactions between varieties and organic fertilizers of number of leaves at 6 WAP reveal that the new dragon variety treated with poultry manure (26.0) produced the highest number of leaves, but it does not differ significantly with the Golden Delight x poultry manure and so also with the other treatments. Moreso, Golden Delight variety in the control plot (12.25) had the lowest significant number of leaves among the treatments at 6 WAP. Data for 10 WAP also follows a similar trend, by which the New Dragon x poultry manure had the highest significant number of leaves (68.25). The control in both varieties produces the least significant number of leaves at mean values of 44.5 and 43.75. Furthermore, the Golden Delight variety in all organic fertilizers tested do not vary significantly ($p<0.05$) with each other at 10 WAP (Figure 1C). Due to more nodes and longer vines, the number of leaves increased as the nitrogen content of the organic fertilizer increased. This corroborated with (Zhang et al., 2019), who reported that nitrogen enhances cell division and elongation, which results in better vegetative growth. Organic fertilisers have the potential of improving the number of leaves of vegetables (Naim et al., 2015). The results obtained from the experiment on the number of leaves plant^{-1} were in conformity with the studies of Lim and Vimala (2012). Interaction effect of variety and different types manure and fertilizer affected the number of leaves plant^{-1} significantly under the present study (Figure 1C). Results from this study confirm the findings of (Hasan and Solaiman, 2012). Organic-fertilizer-treated plots showed a higher number of leaves compared to the control with both varieties. There was a significant increase in the number of leaves from New dragon variety treated with Poultry manure. This result is in accordance with the study of (Awodun, 2007) where they tested goat manure with *Abelmoschus esculentus.*

Effects of interaction between varieties and organic fertilizers on the number of lateral branches.

Figure 1B shows the significant results of interactions between variety and organic fertilizers at 6 WAP for the number of lateral branches. Results for the New Dragon variety in all organic fertilizers tested remain unchanged statistically.

Moreso, all organic fertilizers tested with the Golden Delight variety gave a low significant number of lateral branches. There was an increase in the number of branches in French Dwarf Bean when organic fertilizers were applied (Olfati et al., 2012). Moreso, an increase in the number of lateral branches was reported for tomato crops by Chandra et al. (2014) when treated with vermicompost. It is sufficient to suggest that organic fertilizers can improve the number of leaves in watermelon varieties.

Effects of interactions between varieties and organic fertilisers on leaf area index

Interaction in LAI between the varieties and organic fertilizers at 6 WAP is demonstrated in Figure 1D. All the organic fertilizers show some promises with both the varieties tested. The leaf area index of the New Dragon variety treated with Fish waste Extract, Dolomite, and Vermicompost are significantly different as compared with Golden Delight with a mean value of 0.74, 0.70 and 0.71, respectively. The LAI increased was significantly high from 2 WAP with the application of poultry manure on the New Dragon variety. This indicates that poultry manure was able to increase vegetative growth. Aliyu (2000) previously revealed that poultry manure has a significant impact on the vegetative development of garden eggs and ensures the crop's healthy and vigorous growth. The leaf area index from the application of poultry manure interacted significantly with the New Dragon variety, which was superior to the other combinations. This observation may be due to the release of more nutrients from the highest poultry manure application and improvement in soil physical properties (Dauda et al., 2009)

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Effects of interactions between varieties and organic fertilizers on chlorophyll content

There was an interaction between varieties and organic fertilizers at 6 WAP and 8 WAP in testing the chlorophyll content of tested organic watermelon. At 6 WAP and 8 WAP, both Golden Delight and New Dragon varieties gave higher chlorophyll content when treated with poultry manure at 60.10 and 66.60 SPAD values, respectively. However, the result showed that New Dragon is significantly superior to the Golden Delight variety irrespective of the organic fertilizers used (Figure 2A). An essential function of leaves is to produce assimilation through photosynthesis. One of the major determinants of photosynthetic rate is the amount of chlorophyll in the leaves (Ghosh et al., 2004). In the present study, the New Dragon variety has the highest leaf chlorophyll content as compared with the Golden Delight. This might be so because the New Dragon is better suited to the environment and syntheses light easily, which returns in a higher concentration of chlorophylls in the leaves. The chlorophyll content is influenced by nitrogen levels. Therefore, chlorophyll content is frequently used to estimate plants nitrogen condition.

Effects of Interaction of varieties and organic fertilizers on number of female and combined flowers

The New Dragon variety treated with the seaweed extract produced a significantly higher number of female flowers (3.75); however, it does not differ statistically with the other treatments on both varieties with the exception of the control on all varieties at mean values of 1.75 and 1.76. Similarly, the combined number of flowers for the New Dragon variety showed that Poultry Manure, Fish waste Extract and Seaweed Extract had the highest number of combined flowers with means values at 5.87, 5.75 and 6.0 respectively compared with control (Figure 2C).

Effects of Interaction between varieties and organic fertilizers on days to 50% flowering

Interaction between varieties x organic fertilizers (Figure 2B) shows that the New Dragon variety, irrespective of any organic fertilizers used, gave the least days to reach 50% flowering. However, both varieties Golden Delight & New Dragon (29.5 and 20.5days respectively), treated with poultry manure had the least significant number of days to achieve days to 50% flowering as compared with other organic fertilizers. Results from this study suggest that the application of Poultry manure increases female flower production. In general, high-nitrogen fertilizer and high temperatures encourage the production of female flowers, or ideal blossoms, which leads to increased fruit sets (Eifediyi and Remison, 2010). Days to 50% flowering varies between 29-33 days. It was evident that New Dragon variety took fewer days to achieve days to 50% flowering because of its adaptation to agroecological conditions. The early occurrence of flowering in the New Dragon treated with poultry manure was probably due to nutrient-rich nitrogen release by poultry manure which resulted in crop growth in such plots. Early blooming indicates a brief period of abundant leaf production, as seen in the poultry fertilized plots.

Effects of interactions of varieties and organic fertilizers on fruit weight

Figure 2D demonstrate fruit weight interaction between watermelon varieties and organic fertilizers. Poultry manure produces the highest weight for fruit in the New Dragon variety (15.26 t Ha^{-1}). Moreso, the New Dragon variety performed significantly different from the Golden Delight variety when tested with most organic fertilizers. The Federal Agricultural Marketing Authority of Malaysia (FAMA) reported that the average weight of watermelon varieties ranges between 1.8 kg and 6 kg (Yau et al., 2010). The increase in the marketable yield of fruits results primarily from a significant increase in the single fruit weight from one plant. The present study shows that the New Dragon produced fruits with significantly higher weight than the Golden Delight variety. This result confirms Massri and Labban (2014) study, where they reported that red flesh watermelon variety produces the higher weight of fruits.

Linear correlation between growth and yield parameters

The correlation matrix reveals that vine length has a significant positive correlation with the number of leaves, leaf area index, number of fruits, chlorophyll content, and total soluble solids. However, vine length correlated negatively with the number of lateral branches (r^2 = -0.739). The number of leaves had significant positive correlations with leaf area index (LAI), the number of fruits and TSS content; furthermore, it has a significant negative correlation with lateral branches. The number of lateral branches has correlated statistically with the number of fruits (r^2 = 0.941) and TSS (r^2 = 0.888). There is a significant positive correlation between LAI and chlorophyll

Table 1. Treatments used in the experiment.			
Codes	Treatments	Recommended Rates	Reference
Watermelon Varieties			
V1	Golden Delight	-	-
V2	New Dragon	-	-
Organic Fertilizers			
T1	Control	0 t/ha	-
T2	Poultry Manure	20 t/ha	(Enujeke, 2013)
T3	Goat dung	30 t/ha	(Mowa et al., 2017)
T4	Cow dung	30 t/ha	(Audi et al., 2013)
T5	Fish waste	100 kg/ha	(Ekinci et al., 2019)
T6	Dolomite	4 t/ha	(Kavitha et al., 2015)
T7	Vermicompost	15 t/ha	(Dalorima et al., 2018)
T8	Seaweed extract	10 g/kg of soil	(Wafaa et al., 2015)

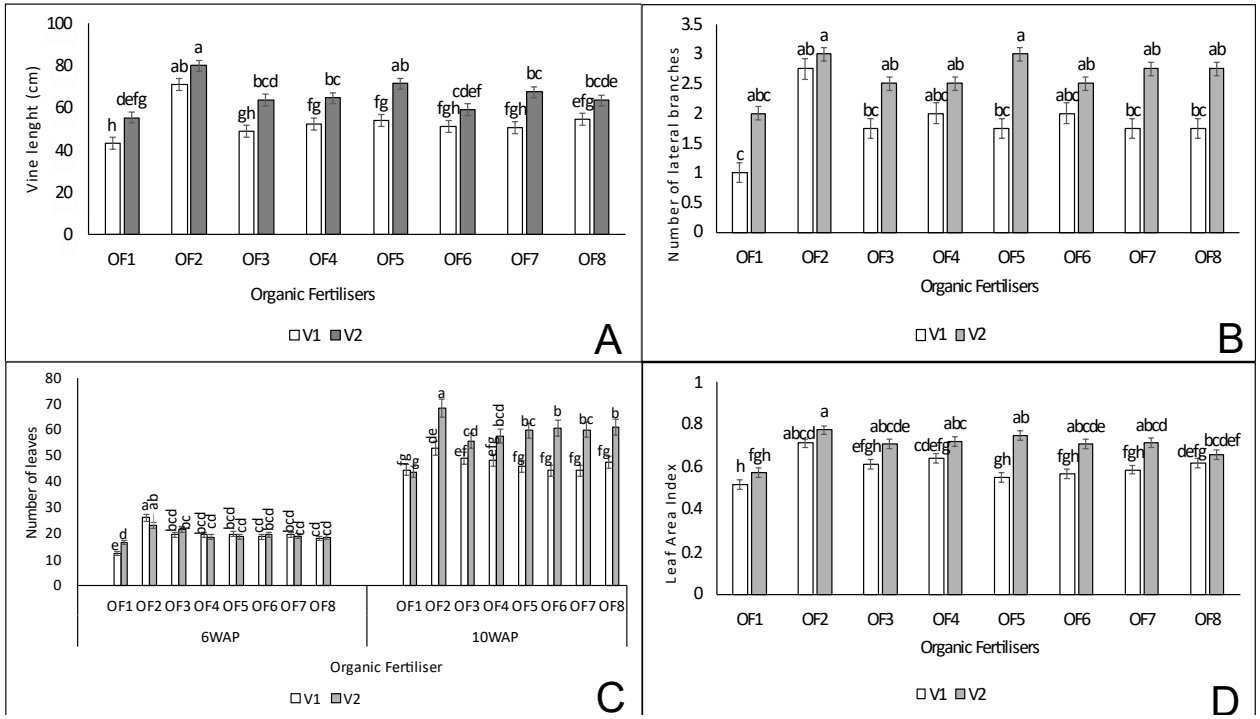

Figure 1. Interaction between varieties and organic fertilisers on (A) vine length at 4WAP, (B) Number of lateral branches, (C) Number of leaves, (D) Leaf area index. Bars indicate ± SE and different letters represent the statistical significance at P<0.05. V1: Golden Delight 363, V2: New Dragon 117, OF1: Control, OF2: Poultry Manure, OF3: Goat dung, OF4: Cow dung, OF5: Fish Waste, OF6: Dolomite, OF7: Vermicompost, OF8: Seaweed Extract.

Table 2. Effects of different types organic fertilizers on vine length and number of leaves of two varieties of watermelon.										
	Vine length (cm)					Number of leaves				
Factors	2 WAP	4 WAP	6 WAP	8 WAP	10 WAP	2 WAP	4 WAP	6 WAP	8 WAP	10 WAP
Varieties (V)										
Golden Delight	10.73a	53.32b	96.31b	155.35b	161.01b	6.03a	10.34b	19.15a	36.19b	47.06b
New Dragon	11.30a	65.65a	100.16a	180.68a	191.52a	8.12a	13.06a	19.41a	40.25a	58.34a
LSD	0.872	1.597	1.591	4.820	3.082	0.587	0.435	0.844	1.663	0.954
Organic Fertilizers (OF)										
Control	11.13c	49.18d	91.26b	151.11c	159.11c	2.50a	7.75c	14.37d	32.87d	44.12c
Poultry Manure	15.73a	75.58a	118.71a	184.14a	193.64a	3.50a	11.37a	24.50a	45.00a	60.62a
Goat Dung	12.31bc	56.36c	96.80b	170.01b	179.26b	3.25a	9.25b	20.50b	36.62cd	52.37b
Cow Dung	12.95bc	58.57bc	96.63b	168.01b	175.76b	3.25a	9.12bc	19.00bc	37.62bcd	52.87b
Fish Waste Extract	12.57bc	62.80b	94.93b	171.66ab	177.78b	2.625a	8.62bc	19.25bc	40.37abc	52.75b
Dolomite	13.36abc	55.29c	94.84b	166.81b	174.94b	3.00a	8.75bc	19.12bc	35.75cd	52.50b
Vermicompost	13.67ab	59.17bc	96.58b	166.44b	173.56b	3.00a	8.75bc	19.25bc	35.62cd	52.12b
Seaweed Extract	12.38bc	58.94bc	96.11b	165.94b	176.07b	3.50a	10.00ab	18.25c	41.87b	54.25b
LSD	2.81	5.15	5.13	15.55	9.94	1.89	1.53	2.72	5.36	3.07
Significance										
V	NS	***	***	***	***	NS	***	NS	***	***
OF	**	***	***	***	***	NS	***	***	***	***
VXOF	NS	*	NS	NS	NS	NS	NS	*	NS	***
Means followed by the same letter(s) within a treatment group in the same column are not significantly different at P<0.05										

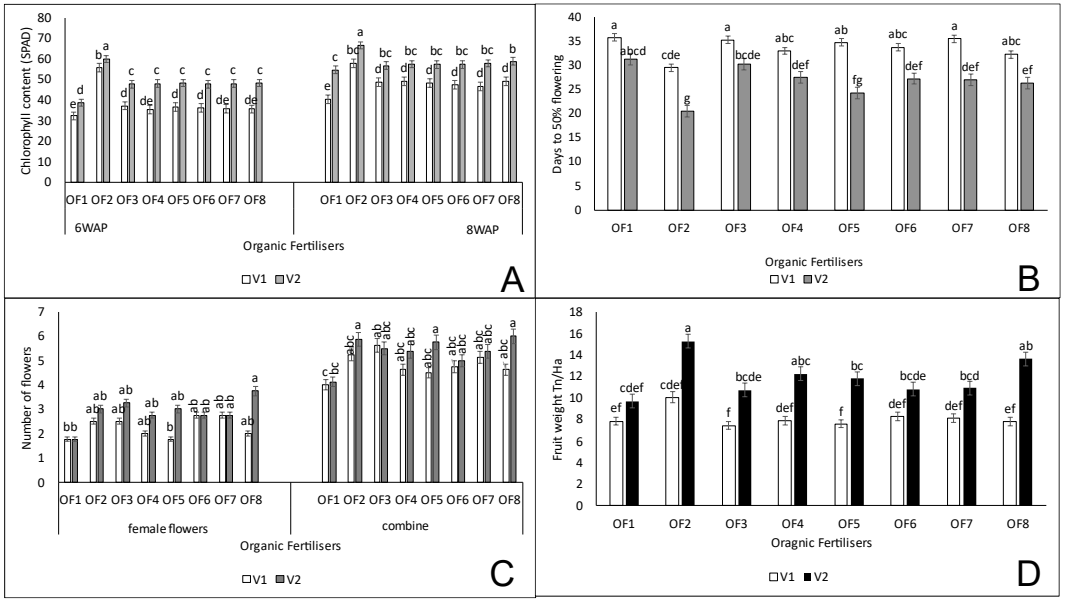

Figure 2. Interaction between varieties and organic fertilizers on (A)Vine length at 4 WAP, (B) Number of lateral branches, (C) Number of leaves, (D) Leaf area index. Bars indicate ± SE and different letters represent the statistical significance at P<0.05. V1: Golden Delight 363, V2: New Dragon 117, OF1: Control, OF2: Poultry Manure, OF3: Goat dung, OF4: Cow dung, OF5: Fish Waste, OF6: Dolomite, OF7: Vermicompost, OF8: Seaweed Extract.

Table 3. Effects of different types organic fertilizers on leaf area index and chlorophyll content of two varieties of watermelon.

	Leaf area index					Chlorophyll content (SPAD)			
Factors	2 WAP	4 WAP	6 WAP	8 WAP	10 WAP	4 WAP	6 WAP	8 WAP	10 WAP
Varieties (V)									
Golden Delight	0.012b	0.38b	0.59b	0.84a	0.60b	30.43a	38.10b	48.42b	38.39a
New Dragon	0.013a	0.43a	0.69a	0.86a	0.67a	30.34a	48.38a	58.37a	39.08a
LSD	0.0005	0.0138	0.0244	0.05	0.022	0.79	0.57	0.69	0.77
Organic Fertilizers (OF)									
Control	0.011c	0.36c	0.54c	0.73b	0.56c	29.41a	35.52c	47.57c	38.56a
Poultry Manure	0.014a	0.46a	0.74a	0.95a	0.70a	30.40a	57.91a	62.23a	39.12a
Goat Dung	0.013ab	0.39bc	0.66b	0.89a	0.65ab	30.97a	42.45b	52.72b	38.91a
Cow Dung	0.013ab	0.39b	0.68ab	0.85ab	0.63b	29.61a	41.72b	53.31b	39.04a
Fish Waste Extract	0.012ab	0.41b	0.65b	0.84ab	0.61bc	30.69a	42.45b	52.76b	38.59a
Dolomite	0.013ab	0.42b	0.64b	0.88a	0.63b	30.29a	41.93b	52.34b	37.99a
Vermicompost	0.013ab	0.40b	0.64b	0.82ab	0.62b	30.06a	41.98b	52.21b	38.67a
Seaweed Extract	0.012bc	0.41b	0.64b	0.84ab	0.65ab	31.61a	41.98b	54.01b	39.00a
LSD	0.00	0.04	0.08	0.15	0.07	2.56	1.85	2.25	2.49
Significance									
V	***	***	***	NS	***	NS	***	***	NS
OF	***	***	***	**	***	NS	*	***	NS
VXOF	NS	NS	*	NS	NS	NS	***	**	NS

Means followed by the same letter(s) within a treatment group in the same column are not significantly different at P<0.05

Table 4. Effects of different types of organic fertilizers on number of branches, number of flowers, days to 50% flowering, number of fruits and weight of fruits of leaves of two varieties of watermelon.

	No of Lateral Branches			Number of Flowers			Days to 50% flowering	No of Fruits		Weight of Fruits	
Factors	6 WAP	8 WAP	10 WAP	Male Flowers	Female flowers	Combine		plant^{-1}	Ha^{-1}	AFW	Tn Ha^{-1}
Varieties (V)											
Golden Delight	1.84b	1.90b	0.56a	7.37b	2.87a	4.81b	33.72a	3.19b	952b	2.72b	8.13b
New Dragon	2.62a	2.47a	0.47a	7.87a	2.25b	5.37a	26.78b	4.81a	143a	3.98a	11.89a
LSD	0.148	0.206	0.25	0.37	0.24	0.24	0.87	0.31	941.08	0.16	0.49
Organic Fertilizers (OF)											
Control	1.50c	1.37c	0.25a	6.37b	1.75a	4.06b	33.50a	2.37c	7098c	2.93c	8.76c
Poultry Manure	2.87a	3.00a	0.87a	8.37a	2.75a	5.56a	25.00d	5.12a	15317a	4.23a	12.65a
Goat Dung	2.12bc	2.12b	0.37a	8.25a	2.87a	5.56a	32.75ab	4.12ab	12328ab	3.04bc	9.08bc
Cow Dung	2.25ab	2.12b	0.50a	7.62ab	2.37a	5.00ab	30.25bc	3.75b	11208b	3.37bc	10.06bc
Fish Waste Extract	2.37ab	2.25b	0.62a	7.87a	2.37a	5.12a	29.50c	3.87b	11581b	3.245bc	9.70bc
Dolomite	2.25ab	2.25b	0.37a	7.00ab	2.75a	4.87ab	30.50bc	4.50ab	13449ab	3.19bc	9.54bc
Vermicompost	2.25ab	2.12b	0.50a	7.75ab	2.75a	5.25a	31.25abc	4.25ab	12328ab	3.19bc	9.54bc
Seaweed Extract	2.25ab	2.25b	0.62a	7.75ab	2.87a	5.31a	29.25c	4.00b	11955ab	3.58b	10.72b
LSD	0.47	0.67	0.81	1.19	0.78	0.78	2.79	1.02	3035.7	0.53	4.49
Significance											
V	***	***	NS	*	***	***	***	***	***	***	***
OF	***	***	NS	***	**	***	***	***	***	***	***
VXOF	*	NS	NS	NS	**	*	*	NS	NS	**	**

Means followed by the same letter(s) within a treatment group in the same column are not significantly different at P<0.05

Table 5. Linear correlations matrix between growth and yield parameters.

	VL	NL	NLB	LAI	CC	DTF	NFL	NF	FW	RT	TSS	JC
VL	1											
NL	0.96**	1										
NLB	-0.74**	-0.80**	1									
LAI	0.89**	0.74**	-0.72**	1								
CC	0.36*	0.25	-0.62**	0.56**	1							
DTF	-0.03	0.04	0.20	-0.04	-0.06	1						
NFL	0.22	0.21	0.24	0.17	0.33	-0.66**	1					
NF	0.81**	0.63*	0.94**	0.95**	0.37	0.53	-0.13	1				
FW	0.10	0.04	-0.04	0.07	0.22	-0.94**	0.69**	-0.58	1			
RT	0.05	0.12	0.23	0.04	0.01	0.88**	-0.71**	0.47	-0.86**	1		
TSS	0.66*	0.70*	0.88**	0.81**	0.44	0.52	-0.11	0.87**	-0.52	0.43	1	
JC	0.27	0.19	-0.27	0.28	0.255	-0.87**	0.75**	-0.55	0.81**	-0.81**	-0.55	1

VL: Vine length, NL: Number of leaves, LB: Number of lateral branches, LAI: Leaf area index, CC: Chlorophyll content, DTF: Days to 50% flowering, NFL: Number of flowers, NF: Number of fruits, FW: Fruit weight, RT: Rind thickness, TSS: Total soluble solids, JC: Juice content.

*Correlation is significant at the P<0.05 level

content (r^2 = 0.561), number of flowers (r^2= 0.953) and TSS (r^2 = 0.816). Days to 50% flowering negatively correlated with flowers, fruit weight, and juice content. The number of flowers has significantly correlated with fruit weight and juice content at P<0.05. Fruit weight correlated negatively with rind thickness. However, it has a significant positive correlation with juice content. There is a significant positive correlation between rind thickness and juice content (Table 5).

Materials and methods

Experimental site and planting materials

A potted experiment was conducted at the research farm of Universiti Malaysia Terengganu located at Bukit Kor, Marang, Terengganu. The site has an annual atmospheric temperature of 21-30°C and relative humidity of 60 - 90%. The physicochemical properties of the soil used is presented in Supplementary Table 1.

The research was laid out as Complete Randomized Design (CRD) with factorial of eight organic fertilizers were used as main factors, and two varieties (V) of watermelon as sub-factors, which were replicated four times. The experiment was. A total of 64 experiment pots were used. The recommended rates of organic fertilizer were used for all the treatments at application. Plant spacing of 2 x 2m between pots was used. In this research, two varieties of watermelons, Golden Delight 363 (Yellow-fleshed) and New Dragon 117 (Red-fleshed) (F1 hybrid), were used as planting materials and different organic manures viz., well-decomposed organic fertilizers were used as the sources of plant nutrients. The choice of materials was based on their widespread cultivation and economic importance. Recommended rates of these organic fertilizers were used in this study (Table 1).

Determination of physicochemical properties of organic fertilizers

The pH value of the organic fertilizers was determined in water extracts as described by Smith (2002). Ground samples were shaken with distilled water in the ratio of 1:10 (w/v) on a reciprocal shaker for 30 minutes and left standing overnight, and pH was then read using a WTW pH 526 meter while EC was read on a WTW Conductivity meter. Total Nitrogen (N) content in the organic fertilizers was determined using an analyzer (CHNS Elementar). After wet-digestion with a mixture of HNO_3:$HClO_4$ (4:1, v/v), the total K concentrations in the organic fertilizers were determined using an atomic absorption spectrometer (Shimadzu 6300). In contrast, P concentration in the solutions was measured calorimetrically by a spectrophotometer. Total organic matter (%) using the modified Walkley-Black method (Adeyemo et al. 2019). CaCO3 content was determined volumetrically using a Calcimeter. Results for organic fertilizers chemical properties used in this study are presented in supplementary Table 2.

Data collection

Measurement of vine length and lateral branches

The Vine length was measured from the base of plants/pot to the growing tip of the main vine using a flexible metric tape. The main vine was chosen from those beginning close to the base of the plant and extending farthest from the base. The Vine length was measured at intervals of 14 days. At the same time, the number of branches and lateral branches of each treatment was counted manually and recorded in the logbook.

Measurement of leaf area index (LAI)

The non-destructive method was used. Leaves from branches are randomly selected from each pot and measured by using the flexible tape, while LAI was computed according to the method described by (Nwaoguala & Law-Ogbomo, 2018) using the equation:

$$LAI = \frac{leaf\ area}{land\ area\ occupied\ by\ the\ plant}$$

Measurement of chlorophyll content

The data for the chlorophyll content index was taken every two weeks. This data was recorded with Konica Minolta Chlorophyll Meter (Model: SPAD 502Plus). The data was

shown as SPAD index. The method used was as described by Khandaker et al. (2017).

Days to 50% flowering and number of flowers

From the initial transplanting of the seedlings to the flowering of 50% of crops on each treatment, the number of flowers and buds on crops is recorded and presented as days to 50% flowering. Male and female flowers were also counted separately and recorded in the logbook.

Number of fruits produced

The total number of fruits at harvest per treatment was counted and recorded as the total yield per hectare.

Statistical analysis

Data were statistically analyses using SAS 9.4 and mean separation was performed for each measured outcome within treatments and varieties using Duncan's multivariate at 5% significant level, significant within treatments based on multiple range test (Tukey-test).

Conclusion

In the present study, it can be concluded that watermelon vine length, number of leaves, number of lateral branches, leaves area index, chlorophyll content, number of flowers, number of fruits, and weight of fruits are significantly higher when treated poultry manure and it was followed closely by seaweed extract. Moreso, the New Dragon variety recorded the higher results in both growth and yield characteristics determined as compared with the Golden Delight variety of watermelon. Correlation analysis between morphological and yield parameters showed that yield parameters positively correlate with growth and development. It is sufficient to conclude that New dragon of watermelon treated with poultry manure gives the best results.

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References

Adeyemo AJ, Akingbola OO, Ojeniyi SO (2019) Effects of poultry manure on soil infiltration, organic matter contents and maize performance on two contrasting degraded alfisols in southwestern Nigeria. Int J Recycl Org Waste Agric. 8: 73–80.

Adeyeye AS, Akanbi WB, Sobola OO, Lamidi WA, Olakekan KK (2016) Growth and fruit yield of water melon (*Citrullus lanatus)* as influenced by compost and npk fertilizer. FUW Trends Sci Technol J. 1: 80–83.

Aliyu L (2000) Effect of organic and mineral fertilizers on growth, yield and composition of pepper (*Capsicum annuum L*.). Biol Agric Hortic. 18: 29–36.

Audi W, Aguyoh JN, Gao-Qiong L (2013) Yield and quality of watermelon as affected by organic and inorganic nitrogen sources. Asian J Agric Food Sci. 1: 180–185.

Awodun MA (2007) Effect of Goat manure and Urea Fertilizer on Soil,Growth and Yield of Okkra. Int. J. Agric. Res. 632-636.

Azeez JO, Van Averbeke W (2010) Nitrogen mineralization potential of three animal manures applied on a sandy clay loam soil. Bioresour Technol. 101: 5645–5651.

Chandra Sharma R, Banik P (2014) Vermicompost and fertilizer application: Effect on productivity and profitability of baby corn (*Zea mays L*.) and soil health. Compost Sci Util. 22: 83–92.

Dalorima TL, Zakaria AJ, Majrashi A, Mahmud K, Mohd KS, Muhammad H, Khandaker MM (2018) Impacts of vermicomposting rates on growth, yield and qualities of red seedless watermelon. Aust J Crop Sci. 12: 1765.

Dauda SN, Ajayi FA, Ndor E (2009) Growth and yield of water melon (*Citrullus lanatus*) as affected by poultry manure application. Electron J Environ Agric Food Chem. 8: 305–311.

Dauda S, Aliyu L, Chiezey U (2005) Effect of variety, seedling age and poultry manure on growth and yield of garden egg (*Solamun gilo* L.). Niger Acad Forum. 9: 88–95.

Efthimiadou A, Bilalis D, Karkanis A, Froud-Williams B (2010) Combined organic/inorganic fertilization enhance soil quality and increased yield, photosynthesis and sustainability of sweet maize crop. Aust J Crop Sci. 4: 722–729.

Eifediyi EK, Remison SU (2010) Growth and yield of cucumber (*Cucumis sativus* L.) as influenced by farmyard manure and inorganic fertilizer. J Plant Breed Crop Sci. 2: 216–220.

Eifediyi EK, Remison SU, Ahamefule HE, Azeez KO, Fesobi PO (2018) Performance of watermelon (*Citrullus lanatus* L.) in response to organic and NPK fertilizers. Acta Univ Sapientiae, Agric Environ. 9: 5–17.

Ekinci M, Atamanalp M, Turan M, Alak G, Kul R, Kitir N, Yildirim E (2019) Integrated use of nitrogen fertilizer and fish manure: effects on the growth and chemical composition of spinach. Commun Soil Sci Plant Anal. 50: 1580–1590.

Emeghara UU, Olukotun O, Olagunju OE, Akanni-John R, Oni BO, Ganiyu L, Yahaya UF, Olafemi SO, Omodona S, Rasheed FM (2020) Effect of different organic manures on the growth and yield of water melon (*Citrullus lanatus*). Asian Soil Res J. 37–43.

Enujeke EC (2013) Response of watermelon to five different rates of poultry manure in asaba area of delta state, Nigeria. IOSR J Agric Vet Sci. 5: 45–50.

Gennari P, Heyman A, Kainu M (2015) FAO statistical pocketbook. World food and agriculture. Food Agric Organ United Nations, Rome, Italy.

Ghosh PK, Ajay, Bandyopadhyay KK, Manna MC, Mandal KG, Misra AK, Hati KM (2004) Comparative effectiveness of cattle manure, poultry manure, phosphocompost and fertilizer-NPK on three cropping systems in vertisols of semi-arid tropics. II. Dry matter yield, nodulation, chlorophyll content and enzyme activity. Bioresour Technol. 95: 85–93.

Hasan MR, Solaiman AHM (2012) Efficacy of organic and organic fertilizer on the growth of *Brassica oleracea* L . (Cabbage). Int J Agric Crop Sci. 4: 128–138.

Kavitha S, Prapagar K, Gunarathne GP (2015) Effect of different rate of dolomite application on tea leaf nutrient content. Int J Environ Sci. 5: 1085–1090.

Khandaker MM, Jusoh N, Hafiza N, Ismail SZ (2017) The effect of different types of organic fertilizers on growth and yield of *Abelmoschus esculentus*. Moench (Okra). Bulg J Agric Sciemce. 23: 119–125.

Lim AH, Vimala P (2012) Growth and yield responses of four leafy vegetables to organic fertilizer. 40: 1–11.

Massri M, Labban L (2014) Comparison of different types of fertilizers on growth , yield and quality properties of watermelon (*Citrllus lanatus*). Agric Sci. 5: 475–482.

Mowa E, Akundabweni L, Chimwamurombe P, Oku E, Mupambwa HA (2017) The influence of organic manure formulated from goat manure on growth and yield of tomato (*Lycopersicum esculentum*). African J Agric Res. 12: 3061–3067.

Naim AH, Ahmed KM, Ahmed FE (2015) Effects of chicken manure on growth and yield of jute mallow (*Corchorus olitorius* L.) under Rain-Fed Conditions of Sudan. OALib. 02: 1–8.

Naz A, Butt MS, Sultan MT, Qayyum MMN, Niaz RS (2014) Watermelon lycopene and allied health claims. EXCLI J. 13: 650–666.

Nthiga EW, Wanjau R, Murungi JI (2014) Levels of chromium in peel, seeds, red flesh and white flesh of varieties of watermelons grown in Kenya. J Kenya Chem Soc Vol 8 Issue. 8: 73.

Nwaoguala NC, Law-Ogbomo KE (2018) Comparative effect of poultry and swine manures on the performance of white guinea yam (*Dioscorea rotundata* Poir) in an ultisols environment. Not Sci Biol. 10: 516–521.

Nwokwu LAG (2015) Effects of organic manure sources on the growth and yield of watermelon in Abakaliki, Southeastern Nigeria. Int J Sci Res. 4: 1923–1927.

Olfati JA, Khasmakhi-Sabet SA, Shabani H, Peyvast G (2012) Alternative organic fertilizer to cow manure for french dwarf bean production. Int J Veg Sci. 18: 190–198.

Schaffer AA, Paris HS (2016) Melons, Squashes, and Gourds. Horticultural reviews. 36(1): 165-198.

Seufert V, Ramankutty N, Foley JA (2012) Comparing the yields of organic and conventional agriculture. Nature. 485: 229–232.

Smith JC (2002) Changes in chemical properties and temperature during the degradation of organic wastes subjected to simple composting protocols suitable for small-scale farming, and quality of the mature compost. South African J Plant Soil. 19: 53–60.

Sodeke VA (2005) Extraction of oil from water melon seed and analysis. Q Res Serv. 2005: 25–30.

Wafaa HM, Seoud IIA El, Alhadad WAA (2015) Effect of organic materials and inorganic fertilizers on the growth , mineral composition and soil fertility of radish plants (*Raphine sativus*) grown in sandy soil. 77–87.

Yau EW, Shamsudin R, Muda N, Chin NL, Hassan O (2010) Physico-chemical compositions of the red seedless watermelons (*Citrullus lanatus*). Int Food Res J. 17: 327–334.

Zhang N, Bao Y, Xie Z, Huang X, Sun Y, Feng G, Zeng H, Ren J, Li Y, Xiong J, Chen W, Yan C, Tang M (2019) Efficient characterization of tetraploid watermelon. Plants. 8: 1–10.