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Comparative Study of Synthetic Fertilizers and Organic Manures on Some Mung Bean (*Vigna radiata* (L.) Wilczek) Genotypes 1-Effect on Growth Parameters and Photosynthesis Productivity

Al-Jawhara A. Al-Owied

Department of Biology, Faculty of Science, Princess Nora bint Abdulrahman University,
P.O. Box 84428, Riyadh, 11681, Saudi Arabia

Abstract: Plant growth is essential for the final production of most crops and also is vital component for producing healthy food for covering human demands and the world's expanding population. Plant nutrients especially in the integrated nutrient management practices are therefore an important component of sustainable agriculture. Two field experiments were conducted during summer season of 2014 and 2015 at Agriculture and Research Station, College of Food and Agriculture Sciences, Derab, King Saud University, Saudi Arabia. The objective of the present study was to evaluate the effect of different organic and synthetic fertilizers sole and/or in combination on growth and photosynthetic leaf pigments contents of two Mung bean genotypes (Kawmy-1and VC- 2010). Experiments, including ten treatments, 2 genotypes x 5 fertilization treatments *viz.,* recommended dose of NPK fertilizer 150: 150: 60 kg ha^{-1} (T1-control); organic manure 10 t ha^{-1} (T2); recommended dose of chemical fertilizer (NPK) + biofertilizer (T3); organic manure 10 t ha^{-1} + bio fertilizer (T4) and organic manure 10 t ha^{-1} + 50 % of recommended dose of NPK fertilizer + bio fertilizer (T5). The results showed that the combinations of recommended dose of chemical fertilizer (NPK) + biofertilizer (T3) and organic manure 10 t ha^{-1} + 50 % of recommended dose of NPK fertilizer + biofertilizer (T5) were mostly increased significantly plant growth and photosynthesis productivity without significant differences between the two treatments.

Key words: Organic manures · Inorganic fertilizers · Mung bean · Bio-fertilizers · Compost

INTRODUCTION

Mung bean (*Vigna radiata* L. Wilczek or *Phaseolus aureus* Roxb.), or green gram, is an important short-duration grain legume crops with wide adaptability against harsh climatic and low water availability conditions. Mung bean also has the ability to improve the soil health by fixing atmospheric nitrogen [1, 2, 3]. In subtropical zones of the world, Mung bean is considered one of the most important sources for protein supplement. Seeds contains about 24–26 % protein, 51 % carbohydrate, 4 % mineral and 3% vitamins [4]. Mung bean seeds can be replaced by meat in many dishes especially for vegetarian due to it's a fat-free and protein enriches [5]. Other different uses of biomass yield in fresh or dry form as a good and valuable for animal feed [6, 7, 8]. Mung bean's world average yield is about 0.4 t/ha while some selective verities of South Asia are capable of producing 2.5 t/ha seeds [9]. Soil health is one of the most important factors for crop production .The most of applied fertilizers are leach down below the root zone, thus farmers are used to application a large amount of synthetic fertilizers, which caused high pollution level of the ground water, causing soil damages and finally led to decreasing crop sustainability. Furthermore, continuous use of chemical fertilizers have had unbalanced of soil nutrients and finally led to consequences a major constraints of productivity, stability and sustainability of soil production. Also, Yadav and Meena [10] found that application of inorganic fertilizers alone in large quantities over a long term of time causes micronutrient deficiencies and the deficiencies of micronutrients have become major constrains of crop production, stability and sustainability of soil health.

Corresponding Author: Al-Jawhara A. Al-Owied, Deanship of Scientific Research, Princess Nora bint Abdulrahman University, P.O. Box: 84428, Riyadh, 11681, Saudi Arabia. E-mail: jao11164@gmail.com.

Generally, excessive amounts of inorganic fertilizers are applied to plants in order to achieve a higher yield and of course high economic return, but such practices is responsible of increasing soil acidity, leads to nutrient imbalance, inhibited growth promoting and finally reflected in seed yield [11]. Most of synthetic fertilizers supplies are deposited during vegetative growth periods and the source sink relationship become proper. The experiments were carried out by Biswas *et al.* [12], Sifola and Barbieri [13] and Shams [14] concluded that application of chemical fertilizers increased the uptake of N, P and K and enhanced the growth parameters. The maximum values were recorded with combined application. Hossain *et al.* [15] evaluated six mungbean genotypes on the basis of photosynthesis productivity under two levels of nitrogen. They found that photosynthesis has generally been considered to be the primary factor affecting the dry matter production in crop plants. The dry matter production and its subsequent conversion into economic yield are the result of a complex physiological process within plants. Their results are in line with those obtained by Mahon [16] and Bushby and Lawn [17], who reported that manipulation of photosynthetic potentials, has been practiced to increase crop productivity for a long time.

Mung bean plants spend nearly about half of their normal growing period in building growth vigor, whereas the rest establishes the yield and yield quality components. Growth parameters have generally been considered to be the primary factor affecting the crop canopy and total dry matter production in most crops. Ahmad and Shad [18] reported that linear relationship between the leaf area and dry matter hold true their hypothesis and thus they concluded that beside environmental and genetic factors, the dry matter production is a function of leaf area in aerated seed of mung bean crop in semi-arid areas. This finding is similar to that reported by Khalil *et al.* [19], Van-Delden *et al.* [20] and Chiu *et al.* [21]. They noticed that leaf area and vertical *L* profile influence the interception and utilization of solar radiation of crop and consequently, the dry matter production. Thus, plant growth and photosynthesis productivity are essential for producing economic and healthy food for covering human demands and the world's expanding population. Qurbanly *et al.* [22] reported that, there is a positive correlation between the nitrogen up takes and leaves chlorophyll content, in the same approaches Chandrasekar *et al.* [23] observed that an increase in chlorophyll content of white millet and wheat leaves respectively, with nitrogen application as compared to control treatment. Integrated nutrient management is therefore a vital component able to maintain soil fertility and sustainable agriculture. The characteristics of nutrient release of chemical, organic and biofertilizers are different and each type of fertilizer has its advantages and disadvantages with regard to crop growth and soil fertility. Integrated use of synthetic fertilizers and organic manures as well as biofertilizers in order to achieve optimum performance by each type of fertilizer and to realize balanced nutrient management for crop growth is most important agronomic practices positively influencing on soils nutrients contain in balance state in order to make optimum use of each type of fertilizer and achieve balanced nutrient management for high crop growth and safeguard environmental quality [24].

Nowadays, the role of biofertilizer is well known in sole application and incorporated with chemical fertilizer recorded highest chlorophyll (a) and (b) contents as compared to control treatment. The experiments of Sifolia and Barbiery [13] on Sweet basil, Shams [14] on kohlrabi, Chandrasekar *et al.* [23] on potato, Selim [25] on lentil, Bekhit *et al.* [26], Kate *et al.* [27] on potato, Golkz *et al.*[28] on Sweet basil, Selim *et al.* [29] on broccoli, Salem *et al.* [30] on potato and Samane *et al.* [31] on sweet basil indicated that an increase in chlorophyll content of some crops leaves, after inoculation with *Azospirillum* bacteria. The increment may be due to the role of inoculation in nitrogen fixation. Keeping above mention review of literature, the present subject in management nutrients research is to formulate an integrated management practice by combining chemical, organic and biofertilizer which are efficient, economic and eco-friendly.

MATERIALS AND METHODS

Planting Material: Mung bean seeds Kawmy-1 and VC 2010 were obtained from National Research Centre, Dokki, Giza, Egypt.

Experimental Site: The present experiments were carried out at Agriculture and Research Station, College of Food and Agriculture Sciences, Derab, near Riyadh, King Saud University, Saudi Arabia (24°42N latitude and 46°44E Longitudes, Altitude 600 m) during summer season of 2014 and 2015. The climate of the experimental region is characterized by low rainfall, high evaporation rates and

Table 1: Monthly data of temperature, relative humidity and total amount of rainfall mm. during the growing period (from March to July during 2014 and 2015 seasons)

	Temperature (°C)									
	Maximum		Minimum		Mean		Relative humidity (%)		Total amount of Rainfall (mm)	
Month	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015
March	23.14	24.83	9.54	10.46	16.34	17.65	24.5	20.5	4.67	2.29
April	27.38	29.10	14.04	14.24	20.71	21.67	16.8	13.2	5.59	0.00
May	34.69	33.33	18.96	18.02	26.83	25.68	10.7	10.0	0.25	2.54
June	42.74	44.45	24.84	25.90	33.83	35.22	10.20	10.34	0.0	0.0
July	44.93	45.72	26.73	27.32	35.80	36.53	12.72	10.46	0.0	0.0

Table 2: Physical and chemical properties of the experimental soil site

Properties	Value
pH (soil paste 1:5)	786
Saturation percentage (%)	29.70
EC (dSm^{-1})	3.88
Organic matter (%)	0.46
$CaCO_3$ (%)	29.42
Field capacity (%)	16.30
Wilting point (%)	7.67
Sand (%)	57.92
Silt (%)	27.20
Clay (%)	14.88
Texture	Sandy loam
Available macro and micronutrients (ppm)	
N	35.40
P	14.80
K	243.50
Fe	3.27
Zn	6.07
Mn	2.44
Cu	0.70

Table 3: Chemical properties of the irrigation water

			Soluble cations ($meqL^{-1}$)				Soluble anions ($meqL^{-1}$)			Macronutrients (ppm)		
pH	EC (dSm^{-1})	OM %	Ca^{++}	Mg^{++}	Na^{+}	K^{+}	HCO_3^-	Cl^-	$SO4^{-}$	N	P	K
7.1	1.45	0.02	6.30	1.75	7.35	0.44	2.40	4.85	9.24	10.50	9.23	7.0

high temperatures during summer season accompanied by low relative humidity. During growth season, agro ecological data *viz.,* mean, maximum and minimum temperature, relative humidity and total amount of rainfall in mm. were recorded are shown in Table 1.

Soil Site and Irrigation Water Properties: Prior to the field experiment, sample of the soil field was taken 0-60cm depth from five sites for physical and chemical analyses according to the methods described by Cottenie *et al.* [32] and Burt [33]. Results showed that soil texture is sandy loam are presented in Table 2. Chemical properties of the irrigation water used were also analyzed according to the methods described by American Public Health Association, APHA [34] as presented in Table 3.

Agronomic Management

Compost Preparation: Four months early, compost was prepared from collecting different organic wastes, decomposed in layer in heap (3 x 7 x 1.5 m), using chemical accelerator i.e., 35 Kg ammonium sulphate, 5 Kg superphosphate, 25 Kg calcium carbonate and 100 Kg organic manure /ton of organic wastes as a microbial activators for fasting decomposition. Heap was maintained under a proper moisture level during the composting course. During the decomposed process, heap was mechanically turned upside down monthly to ensure a good aeration and enhance; biodegradation. Four times homogenized samples were taken for determining C/N ration. At maturity, nearly after 16 weeks, representative samples of surface and the central parts of

Table 4: Chemical properties of compost at maturity (oven dry basis).

Properties	Values
Organic carbon %	14.00
EC dSm^{-1}	2.47
pH	7.76
Total N %	0.60
Available P (ppm)	101.00
C/N ratio	21.80

Table 5: Treatments details

Treatments No.	Treatments details
T1	Recommended dose of NPK fertilizer 150: 150: 60 kg ha^{-1} (control)
T2	Decaying organic compost 10 t ha^{-1}
T3	Recommended dose of chemical fertilizer (NPK) + biofertilizer
T4	Decaying organic compost 10 t ha^{-1} + biofertilizer
T5	Decaying organic compost 10 t ha^{-1} + 50 % of recommended dose of NPK fertilizer + biofertilizer

the heap were taken manually, mixed thoroughly and four replicates of homogenized samples were taken for determining chemical properties of compost and C/N ration, when reached to approximately 18/20, then a good quality compost was produced, brown to dark brown humidified, more stable in form and valuable source of plant nutrients as presented in Table 4.

Field Preparation: Seed bed was prepared before sowing as recommended; field was ploughed with tractor followed by a thorough harrowing to break the clods. The field was properly leveled and divided into plots each plot (3 × 3.5 m) total experimental unit area was 10.5 m^2 earmarked with raised bunds all around to minimize the movement of nutrient. Pipe line was laid to facilitate irrigation to plots individually (irrigation network). The preceding crop was wheat in the winter season in both seasons.

Application of Manures and Fertilizers: Chemical fertilizers, decaying organic compost and biofertilizer as per the treatment details (Table 5) were applied for each sub plots. Recommended dose of NPK fertilizers (120kg N/ha, 160 kg P_2O_5/ha and 60 kg K_2O/ha) were applied after thinning, whereas organic manure was applied during the final ploughing and leveling the ground. Biofertilizer was applied four hours before sowing; seeds were treated with an adhesive material (Arabic gum) to make the seed surface sticky, immediately mixed with multiple bacterial strains (mixture of nitrogen fixer bacteria and phosphate dissolving bacteria (PDB), *Pseudomonas* sp. by the rate of 8 g per Kg seed).

Seed Sowing, Thinning and Weed Management: Seeds were sown by hand drill in lines 50 cm. apart, 3m in length, 2 to 3 seeds per hill. After about 21 days from sowing, seasonal grasses were weeded in all plots by hand hoeing during the initial establishment period and 21 days later the second hoeing was done. After the first time of hand hoeing, plants were thinning to two plants per hill.

Data Collection: During growing seasons different observations on growth characters at 50 and 70 days after sowing (DAS) were done. Five guarded plants at random from each subplot were pulled and tagged for recording different biometric observations *viz.,* plant height cm, (measured from the base of the plant to the tip of the top in each plant sample), number of leaves $plant^{-1}$, number of branches/$plant^{-1}$, total dry weight g $plant^{-1}$ (sample was taken for computation of dry matter, these were dried in an oven at 70°C±5 (four hours or till constant weighed) and leaf area cm^2 (the length and width of the fourth leaf from the tip of the five plant samples were measured in each treatment in cm). Photosynthesis pigment contents (mg/g fresh wt.) were also determined at 30, 50 and 70 DAS *viz.,* (Chl. *a*, Chl. *b*, Chl. *a+b* and carotenoid) using fully expanded leaf (the third one from the top), acetone 85%, as solvent solution and measuring the concentrations by spectrophotometer method and calculated pigments content using the formula described by Von Wettestein [35].

Statisticall Analyses: Data obtained of each season were statistically analyzed by the methods described by Gomez and Gomez [36]. Since the data in both seasons took similar trend Bartletts test was applied and the combined analysis of the data of the two seasons was done. Means were compared by the New Least Significant Difference test (LSD) at 0.05 level of significance which was developed by Snedecor and Cochran [37].

RESULTS AND DISCUSSION

Observations on Growth Characters: Different observations on growth characters at two growth stages (50 and 70 DAS) are presented in Table 6. Plant height, number of leaves plant^{-1}, numbers of branches plant^{-1}, total dry weight g plant^{-1} and leaf area cm^2 were significantly affected by either genotypes or fertilization treatments and their interactions.

Plant Height: According to the analyses of variance and combined data analyses of the two seasons are presented in Table 6, indicated that significant differences between the two genotypes were found. Kawmy-1 recorded higher plant height (67.38 and 85.90 cm) in the first and second growth stages, respectively. These may be due to Kawmy-1 genotype had more genetic potential to produce higher plant vigor. Similarly, the differences among integrated nutrient management were significant in both growth stages. The maximum plant height (70.93 and 94.40 cm) in the first and second growth stages, respectively were produced from plants treated with degree dated organic manure 10 t ha^{-1} + 50 % of recommended dose of NPK fertilizer + biofertilizer (T5), the same trend was also observed in application of recommended dose of chemical fertilizer (NPK) + biofertilizer (T3) which recorded the plant height (67.97 and 87.40 cm) in the first and second growth stages, respectively. Whereas, the minimum plant height (63.78 and 79.59 cm) in the first and second growth stages, respectively was recorded in plants treated with sole application of degree dated organic manure 10 t ha^{-1} (T2).The present results confirmed the data obtained by Biswas *et al.* [12] and Shams [14], they concluded that application of chemical fertilizers in combination with organic or bio fertilizers increased the uptake of N, P and K and enhanced the plant growth vigor.

Number of Leaves Plant^{-1}: The combined data analyses on number of leaves per plant presented in Table 6 indicated that, the differences between two genotypes were insignificant, while significant differences were obtained for plants grown under different management nutrient treatments, as well as interactions between nutrient management and genotypes. Among tested treatments significantly higher values of number of leaves per plant (7.75 and 10.0) in the first and second growth stages, respectively were recorded on plants treated with applying of decaying organic manure 10 t ha^{-1} + 50% of recommended dose of NPK fertilizer + biofertilizer (T5), on par with application the recommended dose of synthetic fertilizer NPK (T1) in the first growth stage (6.65) and recommended dose of chemical fertilizer (NPK) + biofertilizer (T3) in the second growth stage (9.6). The lowest value of number of leaves per plant (5.20 and 7.9) were recorded in the first and second growth stages, respectively in the plants treated with applying of decaying organic manure 10 t ha^{-1}. Also, there are significant differences in interactions among management fertilization treatments and genotypes. The maximum number of leaves plant^{-1} (8.5 and 10.2) in the first and second growth stages, respectively were recorded in Kawmy-1 variety grown under treatment of application of decaying organic manure 10 t ha^{-1} + 50 % of recommended dose of NPK fertilizer + biofertilizer (T5), followed by the same treatment in variety VC2010 (Table 6). Similar results were obtained by Stefan *et al.* [38] reported that inoculation of soybean seeds in the presence of chemical fertilizers recorded significant increase of both number of leaves plant^{-1} and total leaf area.

Number of Branches Plant^{-1}: According to the results obtained from comparison means of number of branches per plant, it is worthy clear that, differences between genotypes were insignificant in the first and second growth stages, whereas the differences among fertilization treatments and their interactions were significant in both growth stages. Application of decaying organic manure 10 t ha^{-1} + 50 % of recommended dose of NPK fertilizer + biofertilizer (T5), followed by applying recommended dose of chemical fertilizer (NPK) + biofertilizer (T3), amounting to 5.80-6.4 and 5.1-5.3, in the first and second growth stages, respectively. These both were however, statistically at par with the recommended dose of NPK. The increase in number of branches plant^{-1} may be due to the effect of same treatments early in plant height as the increasing in the availability of primary growth elements released in sufficient amount for plant absorption. Similar results were also reported by Khan [39].

Total Dry Weight Plant^{-1}: The total dry weight per plant is usually gives a good indication of quantity of energy fixed in plant organs during growing stages and also gives the expected yield later. Results presented in Table 6 indicated that the mean performance and new LSD of the significant cases for the combined analyses of two season's traits of comparative study of two Mungbean genotypes under different management of integrated nutrients. It is worthy clear that significantly higher values of total dry weight criteria were obtained for

Table 6: Growth characters of two Mung bean genotypes grown under different fertilization treatments after 50 and 70 DAS (Combined data of two seasons)

Treatments		First growth sample (50 days after sowing)					Second growth sample (70 days after sowing)				
Variety	Fertilizer treatments	PH	NL	NB	TDW	LA (cm^2)	PH	NL	NB	TDW	LA (cm^2)
V1	T1	66.82	7.0	5.17	24.8	655.78	82.50	9.0	5.2	34.9	734.65
	T2	64.21	5.0	4.16	21.0	420.25	80.22	8.0	5.2	31.8	644.45
	T3	68.25	6.0	4.82	32.0	500.22	90.00	9.7	4.7	37.8	876.92
	T4	64.69	6.0	5.14	25.8	502.98	80.50	8.5	5.4	34.1	754.66
	T5	72.92	8.5	5.94	36.3	673.22	96.30	10.2	6.6	40.5	925.74
Mean	--	67.38	6.5	5.05	27.98	550.49	85.90	9.1	5.42	35.82	813.28
V2	T1	64.69	6.3	5.14	24.2	455.12	80.52	8.2	5.4	36.7	729.65
	T2	63.34	5.4	4.34	21.3	423.81	78.95	7.8	4.5	30.9	623.45
	T3	67.68	6.4	5.34	27.5	462.40	84.80	9.5	5.4	35.8	778.62
	T4	63.48	6.0	4.00	21.2	433.28	80.21	8.2	5.2	33.7	645.14
	T5	68.94	7.0	5.65	29.7	492.31	92.50	9.8	6.2	38.9	785.26
Mean	--	65.63	6.2	4.89	24.78	453.38	83.40	8.7	5.34	35.2	720.42
	T1	65.76	6.65	5.16	24.5	555.45	81.51	8.6	5.3	35.8	732.15
	T2	63.78	5.20	4.25	21.2	422.03	79.59	7.9	4.9	31.4	633.95
	T3	67.97	6.20	5.08	29.8	481.31	87.40	9.6	5.3	36.8	827.77
	T4	64.09	6.00	4.57	23.5	468.13	80.36	8.6	5.1	33.9	699.90
	T5	70.93	7.75	5.80	33.0	582.77	94.40	10.0	6.4	39.7	855.50
LSD for:											
	T	1.47	NS	NS	2.33	58.94	2.12	0.40	NS	0.51	66.85
	V	1.25	0.42	0.32	1.87	24.21	1.13	0.32	0.30	0.82	9.37
	T x V	1.28	0.53	0.46	2.20	8.29	1.25	0.50	0.22	2.14	33.21

PH: Plant height (cm), NL: Number of leaves/plant, NB: Number of branches/plant, LA: Leaf area (cm^2), TDW: Total dry weight/plant (g)

Kawmy-1 genotype amounting to 27.98 and 35.82 g $plant^{-1}$, respectively at 50 and 70 days plant age. Data also showed that reducing the application of chemical fertilizers by 50 % in the presence of decaying organic manure 10 t ha^{-1} and biofertilizer (T5), exhibited maximum total dry weight $plant^{-1}$ amounting to 33.0 and 39.7g $plant^{-1}$ in the first and second growth stages, respectively and it is in par with applying recommended dose of chemical fertilizer (NPK) + biofertilizer (T3). Such effect indicated that management integrated nutrient practices can create higher nutrient availability in root zone, which previously produced tallest plant, more number of leaves and more number of branches $plant^{-1}$ and finally recorded higher dry weight. The previous studies of Ahmed *et al.* [40] concluded that seed yield depends on LA and TDM production in Mungbean. The results obtained in the present study are confirmed with those obtained by Samane *et al.* [31], Islam [41], Ahmed and El-Abagy [42] and Abbasi and Yousra [43].

Leaf Area (cm^2): Leaf area is an important parameter among plant growth characters particularly for interception and conversion of solar energy for effective synthesis of protein and other substances. Leaf area also regulates the source capacity of plants which is further determined by leaf area duration, rates of photosynthesis and respiration. Leaf area is limiting factor in biomass production and it varies with nutrient supply. According to comparison mean presented in Table 6, significant differences between the two genotypes were found, Kawmy-1 surpassed VC-2010 and recorded higher value of leaf area $plant^{-1}$. Significant differences between management fertilization treatments were also observed at the two growth stages. Integrated use of recommended dose of chemical fertilizer (NPK) in combination with decaying organic manures and biofertilizer were significantly produced higher leaf area at all growth stages. This increment can be because of release more nutrition material by effective microorganisms in the soil in root zone and followed by increasing plant vigor as described by Ashour [44]. Furthermore, treated seeds with biofertilizers in the presence of recommended dose of chemical fertilizers (T3), caused significant effect on leaf area mounting to 827.77 cm^2 as compared to sole application of recommended dose of chemical fertilizers 817.15 cm^2. The effect of biofertilizer on leaf are might be attribute to its efficiency in supplying the growing plants with biologically fixed nitrogen, dissolved immobilized phosphorus and produced phytohormones, which could simulate nutrients absorption which finally reflected in increasing photosynthesis process and input in increasing plant growth. Similar, findings of increased leaf area due to integration of nutrient management was reported by Islam *et al.* [45] and Larimi *et al.* [46].

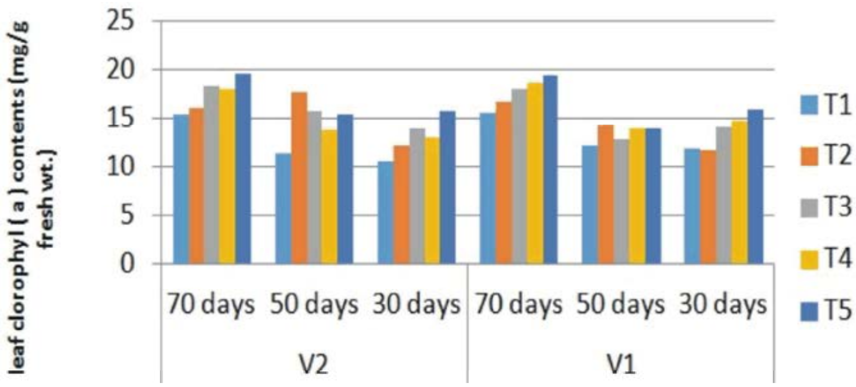

Fig. 1: Photosynthetic pigments contents (Chl. *a*) (mg/g/fresh weight) of Mung bean genotypes grown under different fertilization treatments

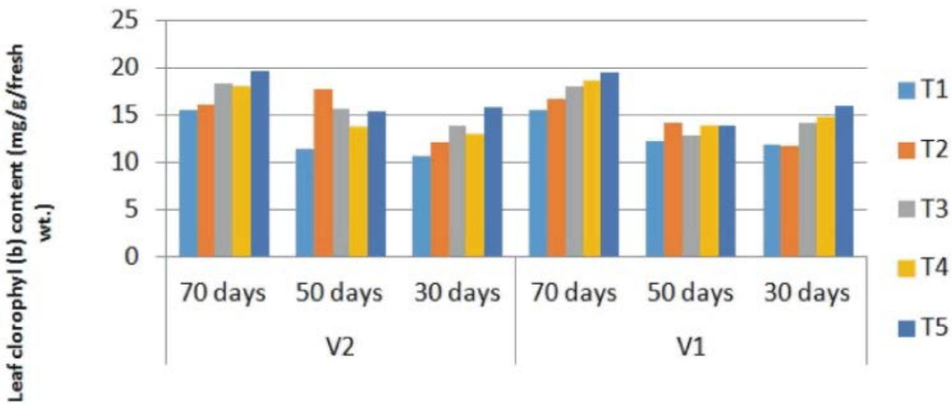

Fig. 2: Photosynthetic pigments contents (Chl. *b*) (mg/g/fresh weight) of Mung bean genotypes grown under different fertilization treatments

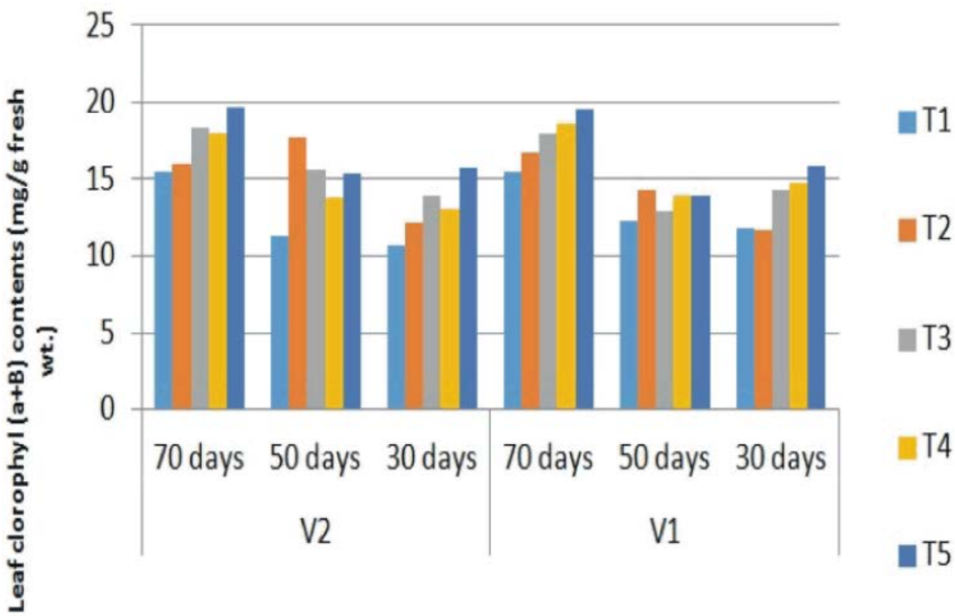

Fig. 3: Photosynthetic pigments contents (Chl. *a*+*b*) (mg/g/fresh weight) of Mung bean genotypes grown under different fertilization treatments

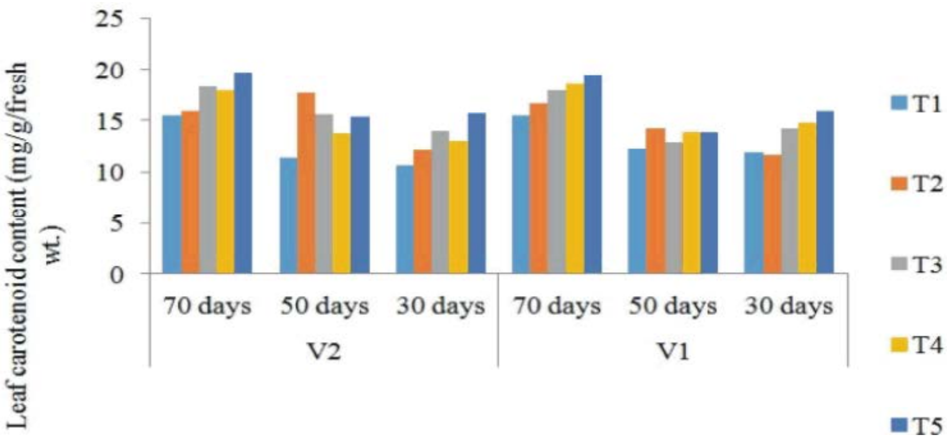

Fig. 4: Photosynthetic pigments contents (Carotenoid) (mg/g/fresh weight) of Mung bean genotypes grown under different fertilization treatments

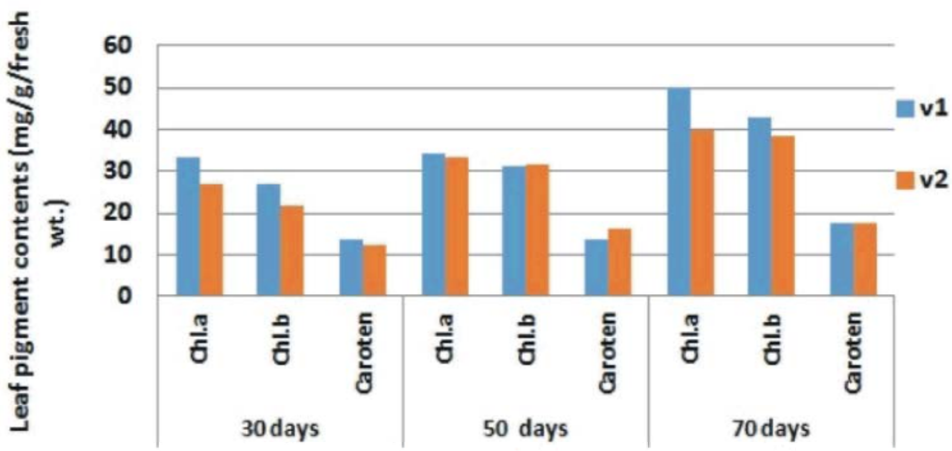

Fig. 5: Varietal different between two Mung bean genotypes on leaf pigments contents (mg/g/fresh weight) grown under different fertilization treatments

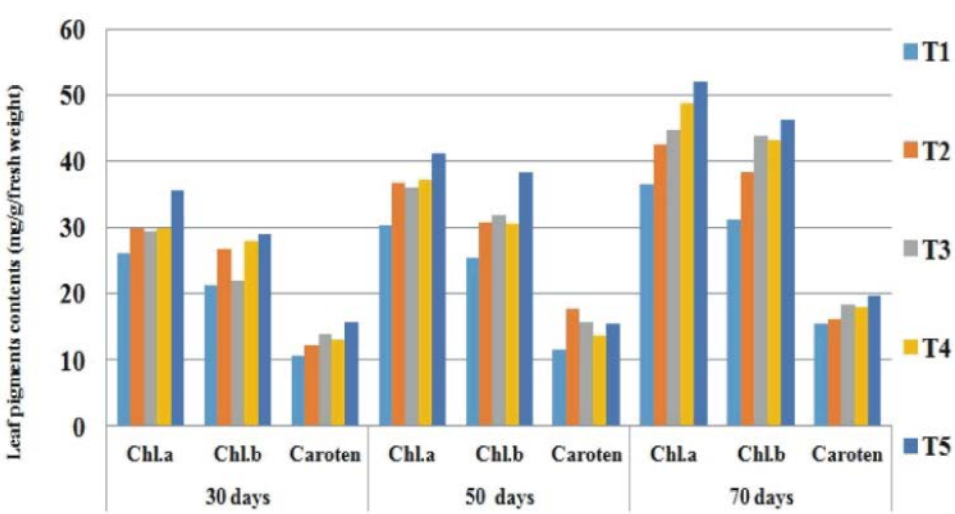

Fig. 6: Effect of fertilization treatments on leaf pigments contents of Mung bean genotypes (mg/g/fresh weight)

Photosynthetic Leaf Pigments Contents (mg/g/Fresh Weight): As shown in Figs. 1, 2, 3 and 4, leaf pigment content *viz.,* Chl. *a*, Chl. *b*, Chl. *a+b* and carotenoid were notably increased gradually by increasing plant age till at 70 DAS (at the time of flowering and pod setting stages). Further, the differences between the both genotypes were significant in leaf pigment content at all growth stages. Kawmy-1 (V1), surpassed the V2 (VC 2010) and recorded the highest values of Chl. *a*, Chl. *b*, Chl. *a+b* and carotenoid 49.97, 42.80, 93.37 and 17.66 at 70 DAS, respectively. Results, also demonstrated that plants treated with integrated nutrient practices (organic manure 10 t ha^{-1} + 50 % of recommended dose of NPK fertilizer + biofertilizer) T5, exhibited maximum leaf pigment contents amounting to 52.05, 46.33 99.48 and 19.68 at 70 day from sowing for Chl. *a*, Chl. *b*, Chl. *a+b* and carotenoid, respectively as compared to application of each sole. In addition, data also cleared that application of biofertilizer in combination with either the recommended dose of synthetic fertilizers (T3) or organic manures (T4) mitigated the reduction detected in application of each sole and recorded an increase in all photosynthesis parameters 44.83, 43.85, 86.38 and 18.33) T3) and 48.78, 43.16, 91.94 and 17.95 (T4) for Chl. *a*, Chl. *b*, Chl. *a+b* and carotenoid, respectively as compared to (T1 and T2) amounting to 36.50, 31.20, 67.70 and 15.49 and 42.53, 38.33, 83.15 and 16.03 for the same parameters, respectively. Over the all treatments, the interactions of V x T were significant in most of photosynthesis leaf pigments content, sowing V1 and application of decaying organic manure 10 t ha^{-1} + 50 % of recommended dose of NPK fertilizer + biofertilizer registered the highest values of photosynthesis leaf pigments content 55.30, 48.70, 107.00 and 19.50 for Chl. *a*, Chl. *b*, Chl. *a+b* and carotenoid at 70 DAS, respectively. Such effect might be due to the improvement in growth performance, higher plant vigor over plant growth periods through the increasing number of leaves and number of branches per plant, leaf area (cm^2) which directly affected on plant nutrients uptake. The present findings are in agreement with those obtained by Shams [14] on kohlrabi, Qurbanly *et al.* [22] on rice, Chandrasekar *et al.* [23] on white millet and wheat leaves, Kate *et al.* [27], Salem *et al.* [30] on potato plants, Larimi *et al.* [46] on sweet basil and Abd El-Gawad [47] on *Vicia faba*. They reported a positive correlation between the nutrients management and the leaf pigment contents of leaves.

CONCLUSION

Insignificant differences between the two varieties were obtained in number of leaves $plant^{-1}$ and number of branches $plant^{-1}$, whereas, plant height, total dry weight per plant and leaf area was significantly affected by genetic differences between the two genotypes. Furthermore, all of these reflected in photosynthesis productivity and caused significant differences between two genotypes. Kawmy-1 surpassed VC-2010 and recorded higher value of each parameters. In the same context, integrated nutrient management practices demonstrated that significant differences are shown in most of studied characters. Over the all treatments, significantly higher values of growth criteria i.e., shoot length, number of leaves $plant^{-1}$, number of branches $plant^{-1}$, fresh and dry mass and leaf area $plant^{-1}$ were obtained for plants of integrated nutrient management practices. The same picture was also noticed on photosynthetic pigments contents (mg/g FW). Moreover, the interactions of V x T were significant in most of mention parameters. Sowing V1 and application of decaying organic manure 10 t ha^{-1} + 50 % of recommended dose of NPK fertilizer + biofertilizer registered the highest growth values.

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