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PRODUCTION OF PEA WITHOUT CHEMICAL FERTILIZERS *VIA* INTEGRATING BIOFERTILIZERS WITH VERMIWASH

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Abstract

Nowadays, the need for safe agricultural production is increasing, depending on the use of chemical fertilizer alternatives for achieving sustainable agricultural development. This study evaluates the production of green peas (cv. Master B) without using chemical fertilizers by integrating the biofertilizers with vermiwash (the liquid that is leached after passing the water through a column of vermiculture units). A field experiment was designed at Giza Agriculture Research Station, Agricultural Research Center, Egypt, during 2018/2019 and 2019/2020 seasons. Treatments of vermiwash only, vermiwash with inoculation of *Rhizobium* (Rh) and plant growth promoting rhizobacteria (PGPR) individual or in combination were compared to recommended chemical fertilizers. Applying vermiwash + Rh + PGPR gave the highest values of root nodulations, plant growth, nutritional content (N, P and K), yield, pod characteristics and seed compositions (protein, carbohydrates and dry matter) of green pea. The plants treated with vermiwash + Rh showed statistically similar results to the chemical fertilizers treatment in all growth, yield and quality traits. Application of vermiwash only gave the lowest values of the same traits. This study concluded the possibility of applying vermiwash with biofertilizers of *Rhizobium* and plant growth promoting rhizobacteria as a substitute of chemical fertilizers to produce a good yield with high quality of green peas.

Key words: Pea, Vermiwash, Vermicompost leachate, Rhizobium, PGPR.

Introduction

Pea (*Pisum sativum* L.) is one of the most important vegetable crops belong to Leguminaceae family. It is one of the most sustainable vegetable crops grown in the world, being nitrogen fixing legume. Cultivation of pea maintains soil fertility via atmospheric nitrogen fixation in its root nodules in symbiotic association with *Rhizobium*, thus plays a vital role in enhancing sustainable agriculture (Negi *et al.,* 2006). In Egypt the cultivated area of green pea is about 47000 feddans (feddan = 0.42 hectare), produced about 200000 tons (Economic Affairs Sector, Ministry of Agriculture and Land Reclamation, 2018).

Sustainable agricultural development needs to find alternatives to chemical fertilizers or limit their use to produce safe food for humans, maintain of soil fertility and environment without pollution. The continuous use of chemical fertilizers only in agriculture causes raising the pollutants in agricultural and groundwater, decreasing soil fertility, deterioration of soil health and reducing the production for area unit (Hernandez *et al.,* 2010).

Vermicompost is a product of organic matter decomposing through integration between earthworms and microorganisms. In this process earthworms feed on the organic waste and convert it into a decomposing form with the help of microbial activity that accelerates degradation rates, as in composting without high temperature (Abduli *et al.,* 2013).

Vermiwash is the liquid leached after saturating the water for a vermicompost unit containing active earthworms and vermicompost at last maturing stages. It is a mixture of earthworm mucous secretions, nutrients, microorganisms and plant growth promoting substances (Gopal *et al.,* 2010), that are washed from the vermicompost into vermiwash leachate. This liquid is rich in amino acids, vitamins, nutrients like nitrogen, potassium, calcium, magnesium, iron, zinc and copper in addition to some growth hormones like auxins and cytokines (Suthar, 2010). In sum, vermiwash is a liquid fertilizer that is easier to add to crops compared to solid organic fertilizers, reduces the amount of solids required for crop production, facilitates fertilizing by farmers and reduces production costs (Pant *et al.,* 2011). Application of vermiwash led

Table 1: Physical and chemical properties of the experimental soil.

Clay%	Silt%	Sand%	Texture	pH	ECdS/m	Cations meq/l				Anions meq/l		
						Ca^{++}	Mg^{++}	Na^{+}	K^{+}	HCO_3^{-}	Cl^{-}	$SO_4^{=}$
41.5	35.2	23.3	Clay loam	7.66	1.73	3.12	1.15	2.83	1.74	2.27	3.75	3.62

to improve plant growth, crop yield and nutritive quality (Gamaley *et al.,* 2001; Pant *et al*., 2011). It is believed that soluble mineral nutrients, amino acids, vitamins and soluble plant growth regulators extracted in the vermicompost leachate have positive effects on initial root development and plant growth with both foliar and soil application (Edwards *et al.,* 2006; Arancon *et al.,* 2007).

Biofertilizers play an important role in maintaining soil productivity and sustainability, thus maximizing crop productivity. They serve as eco-friendly and beneficial to farmers in terms of low cost and ease of use for most crops (Khanna *et al.,* 2019). *Rhizobium* is symbiotic bacteria, associate with the root systems of the legumes and form root nodules for fixing atmospheric nitrogen. The inoculation of legume crops with *Rhizobium* led to improve plant growth and yield (Tagore *et al.,* 2013). Plant growth promoting rhizobacteria (PGPR) are a group of beneficial bacteria that fixing nitrogen, solubilizing phosphate, releasing potassium and promoting plant growth (Joseph *et al.,* 2007; Souza *et al.,* 2015). Application of PGPR lead to colonize the rhizosphere, promote growth, increase nutrient uptake and yield by a combination of mechanisms. They help in promoting free fixing nitrogen, increase supply of other nutrients, such as phosphorus, potassium, sulphur and micronutrients, produce plant hormones like cytokinins, Indole Acetic Acid, Gibberillins (Vessey, 2003; Hafeez *et al.,* 2006; Egamberdieva, 2008; Gholami *et al.,* 2009; Saharan and Nehra, 2011). Many studies showed that the combination of PGPR with *Rhizobium* further enhanced nodulation, root length, the growth, yield and quality of legume plants such as Remans *et al.,* (2007) and Gharib *et al.,* (2015) on bean; Ismail, (2002); Tilak *et al.,* (2006); Gabr *et al.,* (2007); Mishra *et al.,* (2010); Rather *et al.,* (2010) and Pramanik and Bera, (2012) on peas. Many studies showed that the combination of biofertilizers with organic fertilizers further enhanced the growth, yield and quality of plants such as Solaiman and Rabbani, (2006); Zaghloul *et al.,* (2015) and Abo-Basha, (2016) on pea.

Therefore, this work investigates the possibility of integration of biofertilizers with vermiwash to produce green peas without chemical fertilizers.

Material and Methods

A field experiment on pea was implemented at Giza Agriculture Research Station, Agricultural Research Center, Egypt, during two winter seasons of 2018/2019 and 2019/2020. This experiment was performed to produce green peas without using chemical fertilizers by integrating the biofertilizers with vermiwash. The experimental area was plowed and leveled before being divided into plots at area 14 m^2 (5 m length and 2.8 m width), each plot contained four ridges of 0.7 m width and 5 m length. Physical and chemical properties of the experimental soil were presented in table 1.

Plant Material

Seeds of pea (cv. Master B) were sown in the field on the first week of November in both seasons. The seeds were sown twosome at a distance of 10 cm on one side of ridge; furrow system was applied for plant irrigation. The experiment was designed in complete randomized blocks with three replicates.

The Experimental Treatments.

1. Mineral fertilizer as N, P and K (control).
2. Vermiwash (V).
3. Vermiwash + *Rhizobium leguminosarum* (Rh)
4. Vermiwash + PGPR as *Azotobacter chroococcum*, *Bacillus megaterium* and *Bacillus circulans.*
5. Vermiwash + Rh + PGPR.

Preparation of Vermiwash

Vermiwash was produced by modifying the method described by Gopal *et al.,* (2010), where a vermiculture unit consisting of 6 plastic cages (60 × 40 × 20 cm) was installed on top of each other. The down cage was lined with black plastic to collect leachate, while the rest of the cages were lined with a plastic net intended for vermiculture. A layer (5 cm high) of rice straw (soaked in water for a day) was placed at the bottom of each cage, followed by a layer (12-15 kg) of mixture of rabbit manure and squash crop residues (1:1) after composting for two weeks. Steps build a vermiculture unit are demonstrated in fig. 1. Each cage contained 200 g of earthworms (*Eisenia foetida* and *Lumbricus rubellas*). The contents of each cage were watered by 2-3 liters/ week for two months with the leachate was reused in the watering. After two months, each cage was watered by 5 liters every week for month. During this period, the concentrated vermiwash is collected in the down cage and transported to a plastic barrel (100 liters capacity) at once a week for storage until use. The main chemical and microbiological properties of concentrated vermiwash

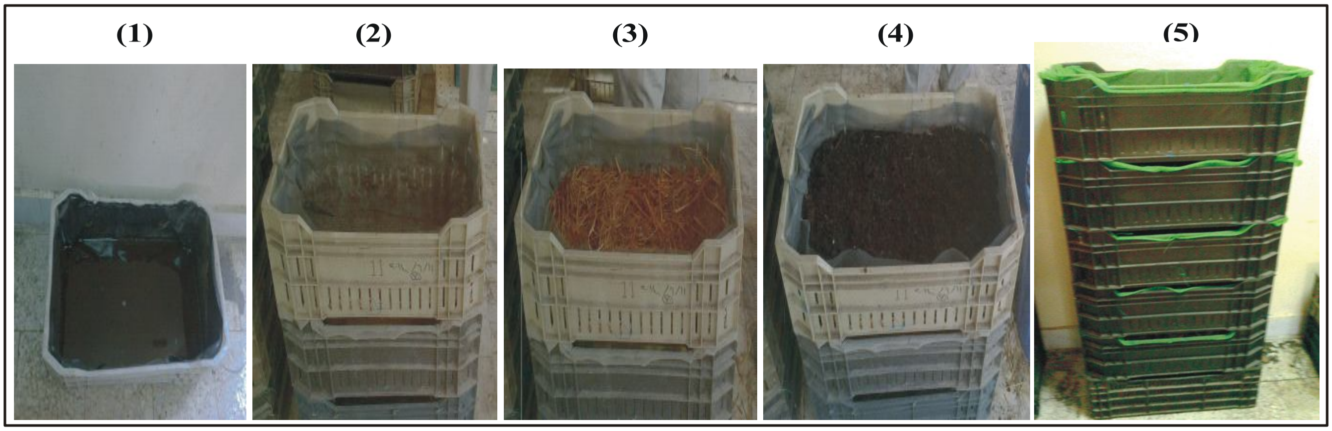

Fig. 1: Steps build a vermiculture unit, respectively.

are illustrated in table 2.

Quantities and Methods of Application

The control treatment was a chemical fertilizers of N, P and K at rates 60 kg N, 30 kg P_2O_5 and 48 kg K_2O/fed expressed as 293 kg of ammonium sulphate (20.5% N), 194 kg of calcium super phosphate (15.5% P_2O_5) and 100 kg of potassium sulphate (48% K_2O), respectively. Calcium super phosphate was added as one dose during soil preparation, whereas ammonium sulphate and potassium sulphate were added at three equal portions, after 2, 4 and 6 weeks from sowing. Seeds of pea were inoculated with *Rhizobium leguminosarum* by using seed coating method at rate 40 g/kg of seeds just before sowing. Plant growth promoting rhizobacteria were applied as a liquid mixture of *Azotobacter chroococcum* (N fixing bacteria), *Bacillus megaterium* (P solubilizing bacteria) and *Bacillus circulans* (K releasing bacteria). Each kind was added at a rate of 5 L/fed (1ml contains 10^6-10^8 cell) according to Mashhoor *et al.,* (2002). PGPR were supplemented to the soils after ten days from sowing seeds. Vermiwash was diluted with water at a ratio of 1:10 approximately at EC 2.5 dS/m (Hashem and Abd-Elrahman, 2016) and applied as a soil application every ten days at a rate of 1L/m^2 (Emam *et al.,* 2020). Addition of vermiwash started after ten days from sowing seeds and continued for two months.

Table 2: The main chemical and microbiological properties of concentrated vermiwash.

Item	Vermiwash
pH	8.43
Ec (ds/m)	6.63
N (mg/l)	82.08
P (mg/l)	31.23
K (mg/l)	29.16
Fe (mg/l)	2.49
Mn (mg/l)	0.94
Zn (mg/l)	0.59
Total count (cfu ml^{-1})	
Bacteria	2.6×10^7
Fungi	1.5×10^2
Actinomycetes	3.2×10^5

Data Recorded

After 60 days from sowing pea seeds, six plants were randomly taken from each replicate for measuring plant growth characteristics expressed as plant length, leaf number/plant and shoot fresh weight. As well as nutritional content (N, P and K) in pea plants were determined in dry matter of the most recent fully developed trifoliate leaves according to Cottenie *et al.,* (1982). Total nitrogen, phosphorus and potassium were determined by Micro Kjeldahl, Spectrophotometer and Flame photometer respectively according to FAO, (1980). Nodules were collected from roots of the same plants manually, counted and weighted, then dried at 70°C for 48 hr to determine the number of root nodules/plant, fresh and dry weight of the nodules.

After 85 days from pea seeds sowing, the pods were harvested weekly for three times. Yield per plant and plot of pea pods were recorded after each harvesting accumulatively. Ten of pea pods from each plot were taken randomly at harvest to estimate pod characteristics as weight, length and diameter. After harvest directly, 150 g of pea seeds were sampled from each experimental unit to determine seed compositions of total protein, total carbohydrates and dry matter. Protein content was determined by N content by 6.25 (AOAC, 2000). Total carbohydrates were determined colorimetrically according to the methods described by Dubois *et al*., (1956). Dry matter was calculated by the following equation:

$$\% \text{ Dry matter} = \frac{\text{Dry weight}}{\text{Fresh weight}} \times 100$$

Statistical analysis

Data of the two seasons were arranged and statistically analyzed by the analysis of variances according to Snedecor and Cochran, (1980) with SAS software, version 2004. Treatment means were compared using Tukey test at significance level 0.05.

Results and Discussion

Data in table 3 show the effect of biofertilizers and vermiwash on nodules characters in root of pea plants during the two winter seasons. In this respect, data mentioned that all nodules parameters (nodule number/ plant, nodule fresh and dry weight) were the lowest in plants fertilized with chemical fertilizers compared to the plants inoculated with the different biofertilizers either in the presence or absence of vermiwash application. This result is agreement with Abo-Basha, (2016) who stated that chemical fertilizers reduced root nodulation in pea plants compared to biofertilizers. The highest values of all nodule characters were monitored in the plants inoculated with Rh + PGPR in the presence of vermiwash. These results are consistent with Remans *et al.,* (2007) and Gharib *et al.,* (2015) on bean; Ismail, (2002); Tilak *et al.,* (2006) and Mishra *et al.,* (2010) on peas; they found that co-inoculation of plants with *Rhizobium* and other biofertilizers resulted in significant increasing nodule number/plant, nodule fresh and dry weight. As well as, the presence of vermiwash as a liquid organic fertilizer that contains the many of growth promoters may have promoted root growth and increased its branching, which led to an increase in the number of nodules on plant roots, especially in the presence of *Rhizobium*. This finding is consistent with Solaiman and Rabbani, (2006) and Abo-Basha, (2016), they indicated that all nodule characters on roots of pea plants enhanced by application of biofertilizers in combination with organic nitrogen fertilizer.

Effect of biofertilizers and vermiwash on growth characteristics of pea plants in both seasons is presented in Table 4. The results cleared that the fertilized pea plants with chemical fertilizers gave the highest values in plant lengths with insignificant differences compared to the plants treated with V + Rh + PGPR. While the treatment of V + Rh + PGPR was superior to other treatments in the number of leaves per plant and shoot fresh weight. Treatment of V + Rh recorded the second greatest leaf number and shoot fresh weight per plant without significant differences with the treatment of chemical fertilizers. Treatment of V + PGPR came in the third order. The lowest values in all growth characteristics were resulted from application of vemiwash only. Increment in the growth of pea plants with using V + Rh + PGPR, might be due to the positive synergistic effect between *Rhizobium* and PGPR for fixing atmospheric nitrogen, increase supply of phosphorus, potassium and micronutrients in the rhizosphere zone that improved the nutrition of the plants, which was reflected on increasing plant growth (Joseph *et al.,* 2007; Tagore *et al.,* 2013; Souza *et al.,* 2015). As well as, this might be due to positive effects of the integration of vermiwash and biofertilizers in providing soluble mineral nutrients, amino acids, vitamins and plant growth regulators like cytokinins, Indole Acetic Acid and Gibberillins that promoted root development and plant growth (Gamaley *et al.,* 2001; Edwards *et al.,* 2006;

Table 3: Effect of biofertilizers and vermiwash on root nodule of characters of pea plants during 2018/2019 and 2019/2020 seasons.

Treatments	Nodule No		Nodule fresh weight (g)		Nodule dry weight (g)	
	1st season	2nd season	1st season	2nd season	1st season	2nd season
ChF	2.733 e	2.960 e	0.158 d	0.161 d	0.015 c	0.015 c
Vermiwash (V)	4.767 d	5.843 d	0.170 d	0.174 d	0.016 c	0.016 c
V + Rh	12.933 b	14.063 b	0.388 b	0. 390 b	0.033 a	0.034 a
V + PGPR	8.833 c	9.943 c	0.215 c	0.219 c	0.020 b	0.020 b
V + Rh + PGPR	18.333 a	19.626 a	0.413 a	0.411 a	0.035 a	0.036 a

Means followed in same column by similar letters are not statistically different at 0.05 level according to Tukey test; ChF = Chemical fertilizers of N, P and K; Rh = *Rhizobium leguminosarum;* PGPR = *Azotobacter chroococcum, Bacillus megaterium* and *Bacillus circulans*

Table 4: Effect of biofertilizers and vermiwash on vegetative growth characteristics of pea plants 2018/2019 and 2019/2020 seasons.

Treatments	Plant height (cm)		Leaf number		Shoot fresh weight	
	1st season	2nd season	1st season	2nd season	1st season	2nd season
ChF	55.97 a	57.20 a	23.38 b	26.00 b	46.64 b	48.473 bc
Vermiwash (V)	43.53 d	45.00 d	18.05 d	20.60 d	36.04 d	38.183 d
V + Rh	51.50 bc	53.33 b	23.51 b	26.67 b	47.31 b	49.120 b
V + PGPR	49.47 c	50.20 c	21.96 c	23.97 c	41.98 c	44.930 c
V + Rh + PGPR	53.60 ab	56.60 a	25.86 a	28.33 a	53.46 a	55.513 a

Means followed in same column by similar letters are not statistically different at 0.05 level according to Tukey test; ChF = Chemical fertilizers of N, P and K; Rh = *Rhizobium leguminosarum;* PGPR = *Azotobacter chroococcum, Bacillus megaterium* and *Bacillus circulans*

Table 5: Effect of biofertilizers and vermiwash on nutritional content of pea plants during 2018/2019 and 2019/2020 seasons.

Treatments	N %		P %		K%	
	1st season	2nd season	1st season	2nd season	1st season	2nd season
ChF	4.787 b	4.790 b	0.355 ab	0.364 b	2.788 ab	2.768 b
Vermiwash (V)	3.771 d	3.867 d	0.262 d	0.287 d	2.081 d	2.146 d
V + Rh	4.730 b	4.773 b	0.325 c	0.334 c	2.520 c	2.524 c
V + PGPR	4.382 c	4.527 c	0.346 b	0.355 b	2.726 b	2.746 b
V + Rh + PGPR	4.868 a	4.993 a	0.370 a	0.385 a	2.846 a	2.860 ab

Means followed in same column by similar letters are not statistically different at 0.05 level according to Tukey test; ChF = Chemical fertilizers of N, P and K; Rh = *Rhizobium leguminosarum;* PGPR = *Azotobacter chroococcum*, *Bacillus megaterium* and *Bacillus circulans*

Arancon *et al.,* 2007; Suthar, 2010).

Data in table 5 are mentioned that the highest concentrations of N, P and K in pea leaves were found in plants that treated by V + Rh + PGPR. Treatment of chemical fertilizers recorded the second highest concentrations of N, P and K in leaves. The treatment of V + Rh statistically gave the same N content that resulted from chemical fertilizers, while the treatment of V + PGPR statistically gave P and K content similar to the chemical fertilizers. On the other hand, the lowest concentrations of N, P and K in plants resulted from application of vermiwash only. Similar findings were noticed in the second season. The cause of the superiority of nutritional content in plants treated with V + Rh + PGPR may be due to the integration of these factors (organic and biofertilizers) in improving the ability of plants to absorb nutrients (Abo-Basha, 2016). Where, vermiwash is rich in dissolved nutrients, amino acids, vitamins and some growth hormones like auxins and cytokines that are easily available for plants (Suthar, 2010; Pant *et al.*, 2011). Besides, the role of *Rhizobium* in supplying plants with N by fixing atmospheric nitrogen in the root nodules (Tagore *et al.,* 2013). As well as, the role of PGPR in free fixing nitrogen, solubilizing phosphate, releasing potassium and producing plant growth promoters in the rhizosphere zone (Vessey, 2003; Hafeez *et al.,* 2006; Egamberdieva, 2008; Gholami *et al.,* 2009; Saharan and Nehra, 2011). All these beneficial substances led to improve of growth and nutritional status of plants.

Table 6: Effect of biofertilizers and vermiwash on yield component of pea plants during 2018/2019 and 2019/2020 seasons.

Treatments	Yield/plant g		Yield/plot (14 m^2)kg		Yield t/fed.	
	1st season	2nd season	1st season	2nd season	1st season	2nd season
ChF	66.597 b	66.697 b	18.727 b	19.027 b	5.873 b	5.883 b
Vermiwash (V)	50.067 d	52.790 d	14.117 d	14.640 d	4.413 d	4.657 d
V + Rh	66.310 b	67.013 b	18.760 b	19.107 b	5.847 b	5.910 b
V + PGPR	59.470 c	60.880 c	17.013 c	17.383 c	5.247 c	5.370 c
V + Rh + PGPR	72.577 a	74.243 a	20.627 a	21.073 a	6.400 a	6.547 a

Means followed in same column by similar letters are not statistically different at 0.05 level according to Tukey test; ChF = Chemical fertilizers of N, P and K; Rh = *Rhizobium leguminosarum;* PGPR = *Azotobacter chroococcum*, *Bacillus megaterium* and *Bacillus circulans*

Table 7: Effect of biofertilizers and vermiwash on the characteristics of pea pods during 2018/2019 and 2019/2020 seasons.

Treatments	Pod weight g		Pod length cm		Pod diameter cm	
	1st season	2nd season	1st season	2nd season	1st season	2nd season
ChF	6.390 b	6.410 b	9.484 b	9.489 bc	1.020 bc	1.035 bc
Vermiwash (V)	5.093 d	5.163 d	8.043 d	8.188 d	0.884 d	0.903 d
V + Rh	6.420 b	6.497 b	9.445 b	9.558 b	1.042 b	1.055 b
V + PGPR	5.877 c	6.037 c	9.019 c	9.204 c	0.970 c	1.012 c
V + Rh + PGPR	7.083 a	7.180 a	10.421 a	10.563 a	1.143 a	1.159 a

Means followed in same column by similar letters are not statistically different at 0.05 level according to Tukey test; ChF = Chemical fertilizers of N, P and K; Rh = *Rhizobium leguminosarum;* PGPR = *Azotobacter chroococcum*, *Bacillus megaterium* and *Bacillus circulans*

Effects of biofertilizers and vermiwash on yield and pod characteristics of pea in both seasons are presented in tables 6 and 7. The results suggested that the plants fertilized with V + Rh + PGPR produced the highest yield per plant and plot, as well as gave the best pod characteristics compared to other treatments. The treatment of V + Rh came in the second order without statistical differences with the chemical fertilizers treatment, whether in relation to the yield or pod characteristics. The treatment of V + PGPR came in fourth order, whereas the treatment of vermiwash only produced the lowest values of yield and pod characteristics. This preference in yield quantity and pod characteristics of V + Rh + PGPR treatment over other treatments, might be explained to its superiority in root nodule number and weight (Table 3), nutrient content of N, P and K in plants (Table 5) which helped in stimulating plant growth (Table 4), resulting increased in photosynthesis and better carbohydrate construction that translocate towards the pods, thus enhanced of yield quantity and pod

Table 8: Effect of biofertilizers and vermiwash on the composition of pea seeds during 2018/2019 and 2019/2020 seasons.

Treatments	Protein (g/100 g)		Carbohydrates (g/100 g)		% Dry matter	
	1st season	2nd season	1st season	2nd season	1st season	2nd season
ChF	5.548 b	5.545 b	14.387 b	14.447 b	23.443 b	23.410 b
Vermiwash (V)	4.490 d	4.629 d	13.920 c	14.020 c	22.653 c	22.670 c
V + Rh	5.492 b	5.559 b	14.406 b	14.507 b	23.553 ab	23.653 ab
V + PGPR	4.915 c	5.140 c	14.198 bc	14.297 b	23.257 b	23.323 b
V + Rh + PGPR	5.793 a	5.964 a	14.909 a	15.067 a	23.953 a	24.013 a

Means followed in same column by similar letters are not statistically different at 0.05 level according to Tukey test; ChF = Chemical fertilizers of N, P and K; Rh = *Rhizobium leguminosarum;* PGPR = *Azotobacter chroococcum*, *Bacillus megaterium* and *Bacillus circulans*

characteristics of green pea. These results are consistent with those obtained by Tilak *et al.,* (2006); Gabr *et al.,* (2007); Rather *et al.,* (2010) and Pramanik and Bera, (2012). They mentioned that application of *Rhizobium* and PGPR for pea plants led to improve root nodulation, plant growth and yield quality. These results also are confirmed by Zaghloul *et al.,* (2015) and Abo-Basha, (2016). They explained that integrating biofertilizers with organic fertilizers led to the production of plants with strong growth, high nutritional content, good yield and quality of peas.

Data in table 8 are showed the effects of biofertilizers and vermiwash on seed compositions of green pea in the two seasons. The results illustrated that application of V + Rh + PGPR produced the highest contents of protein, carbohydrates and dry matter in seeds compared to other treatments. The treatment of V + Rh ranked second order without significant differences with the chemical fertilizers treatment in all these contents, as well as without significant differences with V + PGPR treatment in the contents of carbohydrates and dry matter. Increment of seed combinations with V + Rh + PGPR treatment may be attributed to the promoting effect for integration of biofertilizers (*Rhizobium* and PGPR) with vermiwash, which helped to enhance vegetative growth (Table 4) and nutritional status (Table 5) of pea plants, resulting in increased photosynthesis products of protein, carbohydrates and dry matter that subsequently transferred to storage places in pea pods. These results are harmony with those demonstrated by Zaghloul *et al.,* (2015) and Abo-Basha, (2016), they indicated that integrating biofertilizers with organic fertilizers led to increase the compositions of protein and carbohydrates in pea seeds.

Conclusion

It could be concluded possibility of applying vermiwash with biofertilizers of *Rhizobium* and plant growth promoting rhizobacteria as a substitute of chemical fertilizers to produce a good yield with high quality of green peas.

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