Original Research Article

Impact of organic and inorganic fertilizers on yield and yield contributing characters of Mustard (*Brassica napus* L.)

Abstract

Bangladesh is a densely populated country where the food crisis is one of the major issues. On the other hand, balanced fertilizer used is lacking till now. The purpose of the study is to investigate the yield of Mustard (Brassica napus L.) Binasarisha-9 as influenced by the different applications of organic fertilizers. The experiment was conducted at Bangladesh Institute of Nuclear Agriculture (BINA), substation, Satkhira during the rabi season of 2020-2021 to observe the effect of organic and inorganic fertilizers on the yield of mustard (Brassica napus L.) viz Binasarisha-9 and also find out the best dose of combined application of organic and inorganic fertilizers for optimum yield of mustard (Brassica napus L.) viz Binasarisha-9. The experiment was laid out in a randomized complete block design (RCBD) comprising five treatments (T1= Absolute control, T2=recommended dose chemical fertilizers (RDCF), T3=50% RDCF+ 5t/ha vermicompost, T4= 50% RDCF+ 5t/ha poultry manure, T5= 50% RDCF+ cow dung) with three replications were executed to conduct the study. Mustard (Brassica napus L.) was responded significantly at T3 treatment (50% RDCF+ 5t/ha vermicompost). The highest mustard yield was recorded (2.14 ton/ha) from T3=(50% RDCF+ 5t/ha vermicompost) treatment whereas the lowest mustard (Brassica napus L.) yield (0.81 ton/ha) was obtained from T1= (absolute control) treatment. Balanced nutrient management application significantly increased mustard yield compared to the imbalanced treatment. Organic fertilizers (vermicompost, poultry manure, cow-dung) showed better nutrient uptake as compared to chemical fertilizers. However, vermicompost tended to be the most suitable organic source for higher yield and thus is the proper substitute of the most commonly used nutrient sources for the production of mustard.

Keywords: Vermicompost, Fertilizers, Cow-dung, Yield, Mustard (*Brassica napus* L.).

Introduction

Mustard (*Brassica napus L.*) is a plant of broadleaf, cruciferous, and a member of cole crops under the family of Brassicaceae and worldwide a source of cocking oil (Rahman, *et al*., 2018). Rapeseed and mustard are one of the popular oil-producing crops grown in the rabi season of Bangladesh (Kumar, *et al*., 2014). Brassica, is one of the most important oilseed crops and a principle source of vegetable oil, with 2,70,018 hectors under cultivation and a production of 311740 tones in 2019 (FAOSTAT, 2019). Mustard is mostly used at the table as a condiment on cold and hot meats. Sometimes it is used as a component in mayonnaise, vinaigrette, marinades, and barbecue sauce and also a famous accompaniment to hot dogs, pretzels, and bratwurst. Due to warming properties, mustard seeds are used in medicine for example mustard plasters. In cosmetology, mustard is used to strengthen hair, cleanse the face and stimulate blood circulation. There are two types of mustard seeds viz black and brown. Black seeds are mostly globular in shape, finely pitted, and odorless whereas brown mustard seeds are light yellow and about 2.5 mm in diameter. Brown mustard seeds which are related to rapeseeds is grown as a source of vegetable oil and is an important crop for industrial purpose with the residual used for animal feed. Yellow mustard seeds are mostly known for their delicate and spicy taste. They are used for whole or milled for preserving vegetables, mushrooms, fish, for cooking vegetable dishes, pork, various game, and meat soups, etc. The bulk of the seeds are used in making a mustard sauce to retain the fragrance. Both types of seeds have similar ingredients: about 35 to 42 percent vegetable oil along with a slightly smaller proportion of protein and a strong enzyme called myosin. Mustard seeds when used as a condiment is sold in three forms: as seeds, as dry powder that is freshly mixed with water for each serving to obtain the most aroma and flavor and made as a paste with other spices or herbs, vinegar or wine, and starch or flour to tone down the sharpness. To affiliate, the yield of the crop, plenty of chemical fertilizers along with a small number of organic fertilizers were being used by different workers which ultimately affects the soil as well as human (Meena, *et al*., 2017).

The imbalance use of chemical fertilizers in crop production is a common phenomenon in Bangladesh. As a result, the yield of crops declined due to depleted soil fertility therefore integrated nutrient management is an important demand of the present *era* (Attigah, *et al*., 2013). Organic fertilizers can play a vital role in sustaining soil fertility and crop production. Besides in Bangladeshi soil, the amount of organic matter is very poor (Ali, et al., 2014). It is a fact that the use of chemical fertilizers for crop production isn't good for soil health due to residual effects while using organic fertilizers does not create such a problem. Moreover, it increases the productivity of soil as well as crop quality and yield (Tindall, 2000). The displacement and assortment of nutrients vary due to variation in mobility and competition of metals with other nutrients within the plant system (Tibbett, *et al*., 2021). In Bangladesh, farmers use chemical fertilizers for the readily available source of nutrients but they do not apply in balance formation. It impacts on shortage of micronutrient concentrations affecting the yield of different agricultural crops (Tripathi, *et al*., 2015). On the other hand, organic matter content in Bangladeshi soil is very poor and is being depleted gradually (*Ali, et al*., 2014). Neither chemical fertilizer nor organic manure alone can help in achieving sustainable crop production. Even with the balanced use of only chemical fertilizer, high yield levels could not be maintained over the years because of deterioration in soil physical, chemical, and biological properties (Khan, *et al*., 2008). Integrated nutrient management is the best approach to maintain soil fertility and productivity on a sustainable basis.

Materials and Method

Experimental site and design:

The experiment was conducted at the Bangladesh Institute of Nuclear Agriculture (BINA), sub-station, Satkhira during the rabi season of 2020-2021 to observe the effect of organic and inorganic fertilizers on the yield of Binasarisha-9 and also find out the best dose of combined application of organic and inorganic fertilizers for optimum yield of Binasarisha-9. The soil belonged to the AEZ-11 and AEZ -13. The land topography was medium-low. The soil of the experimental field is loam in texture with pH 5.7. The experiment was laid out in a Randomized complete block design (RCBD) with five treatments. There were 15 plots each having the dimension of 4m X 3m=12m2. Distance between replication to replication was 1 m and line to line 25 cm. However, the five treatments were as follows, (T1= Absolute control, T2=recommended dose chemical fertilizers (RDCF), T3=50% RDCF+ 5t/ha vermicompost, T4= 50% RDCF+ 5t/ha poultry manure, T5= 50% RDCF+ cow dung) and RDCF=$N_{210}P_{185}K_{124}S_{124}Zn_{10}B_5$.

Soil sampling and analysis: Soil samples were collected to a depth of 0-15 cm before initiation of the experiment and after harvesting of crops. Before initiation and the completion of the experiments, composite soil samples were collected from each plot (three replications) at 0-15 cm depth. Three auger samples were taken from each plot and divided into two sets of sub-samples. The collected samples were then air dried and ground to pass through a 2 mm (10 meshes) sieve and stored in a clean plastic container for physical and chemical analyses. Then after harvesting of mustard, soil sample was collected from each plot. After removal of all debris, composite soil sample was made by treatment wise and the soil was labeled as post soil. The soil was air dried in room temperature. Then pH, organic matter, organic carbon (%), total N (%), available P (ppm), exchangeable K (meq/100g soil), S, Zn, B and all other physical and chemical properties were analyzed of initial soil and post soil as presented in (

Table 01, **Table 02**,

Figure 02: Impact of organic and inorganic fertilizers on yield (ton/ha) of mustard (Brassica napus L.) Binasarisha-9.

Table 05) by the standard methods of Jackson (1973); Nelsons and Sommers (1982); Black(1965); Olsen and Sommers (1982); Thomas (1982).

Field measurement of soil salinity:

Soil salinity at different dates was recorded at 08:00-10:00 a.m. every 7 days interval, starting from sowing until harvest. The salinity was measured by EC meter (HANNA: HI 9835). Data were taken in the middle of the plot. Collected data were analyzed using the ANOVA procedure. Once a week, a calibration for the meter was made by comparing it with laboratory data and results have been shown in (**Table 02**).

Seed sowing, crop and data management:

The crop variety was mustard (*Brassica napus* L.) viz Binasarisha-9. There were 15 plots each having the dimension of 4m X 3m and the distance between replication to replication was 1 m and line to line distance 25 cm. Mustard seeds were sown on 18 November 2020. The fertilizers dose was 210, 185, 124, 124, 10, and 5 kg/ha N, P2O5, K2O, S, Zn, and B respectively. One-third of urea is basal dose and the rest of urea is of two equal split doses at 25 DAS and 45 DAS respectively.

Optimum irrigations were applied when needed to the crop. Thinning was done at the 2-3 leaf stage to maintain the line-to-line distance of 25 cm. The crop was kept weed-free and insect pests were also controlled with the proper application of chemicals. Disease and insect pests were always well controlled using suggested applies. The crop was harvested manually after its maturity on 13 February 2021 and collected data were analyzed statistically by F-test. The mean differences of the treatments were observed by the least significant difference (LSD) test at a 5% level of probability for the interpretation of results (Gomez and Gomez, 1984).

Table 01. Physical properties of the initial soil of the experimental plot, 2020-2021

Particle size distribution	Value
Sand (%)	47
Silt (%)	24
Clay (%)	29
Textural class	Clay Loam
Bulk density (g/cm^3)	1.32
Particle density (g/cm^3)	2.27
Total porosity (%)	43.56

Table 02: Chemical properties of the soil of mustard at the substation, Benarpota, Satkhira during the rabi season of 2020-2021

Soil characteristics	Analytical value (Initial soil)	
	Value	Interpretation
Soil p^H	5.7	Slightly acidic
Organic matter (%)	1.20	Moderate
Organic C (%)	0.70	
Total N (%)	0.072	Very low
Available P (ppm)	14.60	Medium
Exchangeable K (meq/100g soil)	0.11	Low
Available S (ppm)	6.67	Very Low
Available Zn (ppm)	0.43	Very low
Available Boron (ppm)	0.27	Medium

Results and Discussion:

The effect of vermicompost, poultry manure, and cow dung in combination with inorganic fertilizers on the 50% flowering days, growth maturity (days), plant height (cm), and branches/plant of Binasarisha-9 have been presented in (

Table 03). Significant variations (P≤0.05) were observed in 50% flowering days, growth maturity (days), plant height (cm), and branches/plant of Binasarisha-9 when vermicompost, cow dung, and poultry manure were incorporated into the soil. Among the treatments, T3 treatment showed the early flowering (40.33 days), growth duration (83.67 days), highest plant height (92.0 cm) of Binasarisha-9. There was significant variation in the number of branches/plant (8.33) of Binasarisha-9 where 50% recommended dose chemical fertilizers with 5 ton/ha vermicompost were used and the least mean of 50% flowering (47.00), growth duration (92.00), plant height (66.00) and branches/plant (2.33) were recorded from T1 (absolute control) where no fertilizers were used.

Table 03: Impact of organic and inorganic fertilizers on growth attributes of mustard (*Brassica napus* L.) Binasarisha-9.

Treatments	50% flowering days	Growth duration (days)	Plant height (cm)	Branches/Plant
T1	47.00 a	92.33 a	66.00 d	2.33 d
T2	44.33 b	87.67 b	89.33 b	4.33 c
T3	40.33 d	83.67 d	92.00 a	8.33 a
T4	42.67 c	85.33 c	85.67 c	6.33 b
T5	43.33 bc	84.77 cd	86.00 c	5.00 c
LSD 0.05	1.3534	1.1139	2.3567	0.8764
CV%	1.65	0.68	1.49	8.84

In a column figures having similar letter (s) do not differ significantly whereas figures with dissimilar letter (s) differ significantly as per LSD at 5% level of probability.

Recorded data in respect of siliquea/plant, seeds/siliquea showed that the effect of organic and inorganic fertilizers i.e. alleviate doses of fertilizers with organic fertilizers was significant at all stages of yield/ton. (

Table 04) indicate that maximum siliquea/plant (66.67), seeds/siliquea (26.33), 1000 seeds weight (3.59 gm) and yield/plot (2.57 ton/ha) were recorded from T3 treatment (50%RDCF+5 ton/ha VC). On the other hand, the least mean value of siliquea/plant (28.67), seeds/siliquea (18.67), 1000 seeds weight (2.46 gm), and yield/plot (0.97 ton/ha) were observed in T1 (absolute control) treatment. Similar results due to the effect of integrated nutrient management were reported by (Mohapatra, et al., 2013), (Shree et al., 2014), (Meena, et al., 2017).
That's why we should try to adjunct a part of chemical fertilizer along with organic ones and application of vermicompost and other fertilizers gave a better performance for the enhancement of yield of Binasarisha-9. As far we know that organic fertilizers can serve as an alternative practice to mineral fertilizers for improving soil structure and microbial biomass (Dauda et al., 2008).
Vermicompost has a tea-like structure and more nutrient-rich organic fertilizer than other organic fertilizers. It has been reported that vermicompost might have improved soil porosity, soil structure, water-holding capacity, and purvey other growth-promoting substances. Moreover, vermicompost significantly increased plant height. A similar result was reported by (Walker and Bernal, 2004).

Table 04: Impact of organic and inorganic fertilizers on yield attributes of (*Brassica napus* L.) Binasarisha-9.

Treatments	Siliquae/Plant	Seeds/siliquae	1000 seeds weight(g)	Yield/plot (Kg)
T1	28.67 d	18.67 c	2.466 d	0.976 d
T2	47.00 c	23.33 b	2.857 c	1.84 c
T3	66.67 a	26.33 a	3.587 a	2.57 a
T4	56.00 b	24.33 b	3.313 b	2.40 b

T5	51.67 bc	24.00 b	3.321 b	2.35 b
LSD 0.05	5.0346	1.4174	1.44	1.57
CV%	5.35	3.25	0.0843	0.0599

In a column figures having similar letter (s) do not differ significantly whereas figures with dissimilar letter (s) differ significantly as per LSD at 5% level of probability.

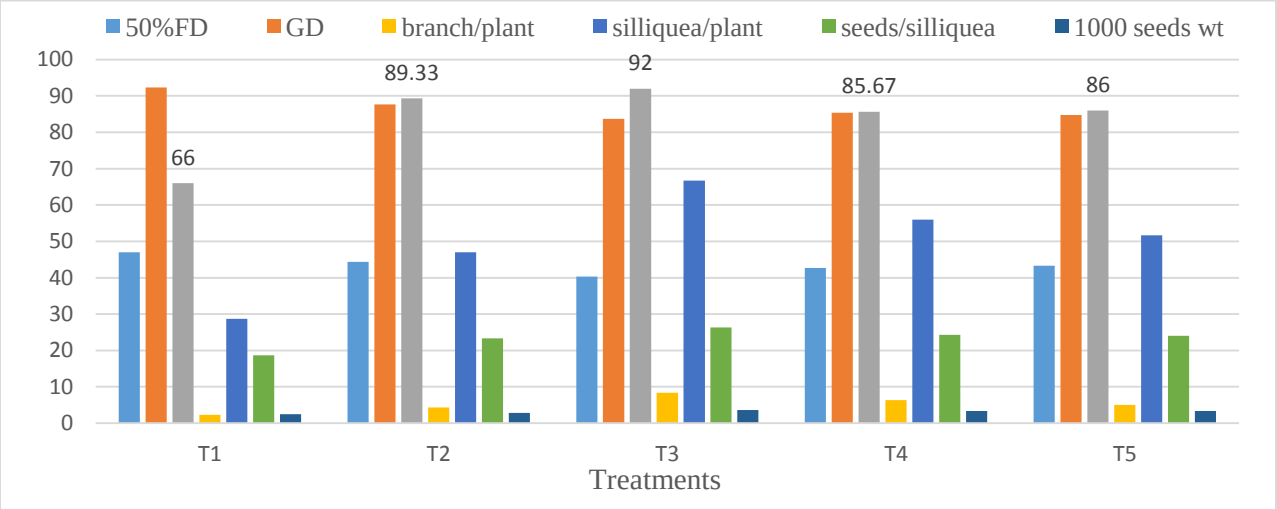

Figure 01: Effect of inorganic and organic fertilizer on growth and its attributing characters of mustard (*Brassica napus* L.) Binasarisha-9.

Yield ton/ha:

Use of different level of organic fertilizers along with inorganic fertilizers increased the yield of mustard significantly. Among different types of organic fertilizers (vermicompost, cow dung and poultry manure) in combination with inorganic fertilizers, the maximum yield was recorded (2.14 ton/ha) from T_3 treatment (**Figure 02**) which was statistically significant from T_1 (0.81 ton/ha), T_2 (1.53 ton/ha), T_4 (2.00 ton/ha) and T_5 (1.96 ton/ha) respectively. The least yield was recorded from T_1 (0.81) treatment (control).

Figure 02: Impact of organic and inorganic fertilizers on yield (ton/ha) of mustard (Brassica napus L.) Binasarisha-9.

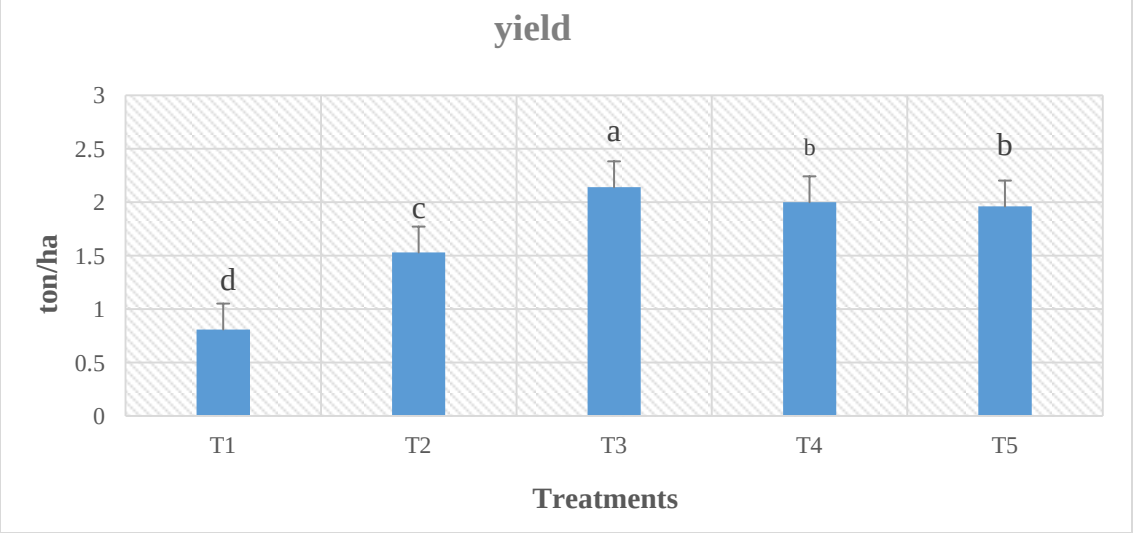

Table 05: Chemical properties of the soil of mustard at the substation, Benarpota, Satkhira during the rabi season of 2020-2021

Soil characteristics	Analytical value (Soil after harvest)	Critical levels	
	Value	Interpretation	-
Soil p^H	6.4	Slightly acidic	-
Organic matter (%)	1.39	Moderate	C:N= 10:1
Organic C (%)	0.81		C:N= 10:1
Total N (%)	0.10	Very low	0.12
Available P (ppm)	20.21	Optimum	10.0
Exchangeable K (meq/100g soil)	0.19	Moderate	0.12
Available S (ppm)	10.42	Low	10.0
Available Zn (ppm)	0.39	Very low	0.6
Available Boron (ppm)	0.33	Medium	0.2

Conclusion:

Among all the treatments T3 performed the maximum yield (2.14 ton/ha). The influence of inorganic and organic fertilizers on 50% flowering days, growth duration, plant height,

branches/plant, siliquea/plant, seeds/siliquea, 1000 seeds weight, and yield/ton of mustard (Binasarisha-9) sought to be increased in the treatment receiving nitrogen fixation through vermicompost leads to increase the yield of mustard per plot or yield ton per hector. This results semblance with finding with (Kumar, et al., 2013). Hence, soil application of 50%RDCF with 5 ton/ha vermicompost was found to be the best for obtaining the maximum yield (2.14 ton/ha).

References

1. FAOSTAT (Statistics Division, Food and Agriculture Organization of the United Nations). Crops-Rice; 2021. Availble:http://www.fao.org/faostat/en/#data/QC, accessed on 29 May 2021.
2. Attigah AS, Asiedu EK, Agyarko K, Dapaah HK. Growth and yield of okra (*Abelmoschus esculentus* L.) as affected by organic and inorganic fertilizers. ARPN: J. Agri. Biol. Sci 2013;8(12):766-770.
3. Ali, M. M., Shaheed, S. M. & Kubota, D. (2014). Soil degradation during the period 1967-1995 in Bangladesh. II Selected chemical characters. *Soil Sci. and Plant Nutr.* 43(4), 879-890. http://dx.doi.org/10.1080/00380768.1997.10414654.
4. Black, G. R. (1965). *Bulk density.* In: Black, C. A. (ed.). Methods of Soil analysis, Part 1. *American Society of Agronomy*, Monograph Series no. 9, 374-390. http://dx.doi.org/10.2134/agronmonogr9.1.c30
5. Dauda, S. N., Ajayi, F. A. & Noor, E. (2008). Growth and yield of water melon (Citrullus lanatus) as affected by poultry manure application. J. Agric. Soc. Sci. 4, 121-4.
6. Gomez, K. A. & Gomez, A. A. (1984). Statistically Procedures for Agricultural Research. 2nd edition. *An International Rice Research Institute Book.* A wiley-Inter science Publication, New York, 28. pp. 442-443.
7. Rahman, M.; Khatun, A.; Liu, L.; Barkla, B.J. Brassicaceae Mustards: Traditional and agronomic uses in Australia and New Zealand. Molecules 2018, 23, 231.
8. Jackson, M. L. (1973). Soil chemical analysis. *Advanced course.* 2nd ed. M. L. Jackson, Madison, WI.
9. Khan, M. S., Shil, N. C. & Noor, S. (2008). Integrated nutrient management for sustainable yield of major vegetable crops in Bangladesh. *Bangladesh J. Agric. Environ*. 4, 81-94.
10. Kumar M, Das B, Prasad KK, Kumar P. Effect of integrated nutrient management on growth and yield of broccoli (*Brassica oleracea* var. *italica*) under Jharkhand conditions. Veg. Sci 2013;40(1):117-120.
11. Kumar, P.; Kumar, A.; Kumar, S.; Kumar, P. Effect of zinc and iron application on yield and acquisition of nutrient on mustard crop (brassica juncia L.). J. Plant Develop. Sci. 2014, 6, 413–416.
12. Mahanta R, Nandi AK, Mishra SP, Pattnaik A, Hossain MM, Padhiary AK. Effects of integrated nutrient management on growth, yield, quality and economics of sprouting broccoli (*Brassica oleracea* var. *italica*) cv. Shayali. Journal of Pharmacognosy and Phytochemistry, 2018;7(1): 2229-2232.
13. Meena K, Ram RB, Meena ML, Meena JK, Meena DC. Effect of Organic Manures and Bio-Fertilizers on Growth, Yield and Quality of Broccoli (*Brassica oleracea* var. *italica Plenck*.) cv. KTS-1. Chem Sci Rev Lett 2017;6(24):2153-2158.
14. Nelson, D. W. & Sommers, L. E. (1982). Total carbon, organic carbon and organic matter. In: Page, A. L. (ed). Methods of soil analysis. Part 2, 2nd ed. *Agron. Monogr. 9*, ASA and SSSA, Madison WI. pp. 539-580.

15. Olsen, S. R. & Sommers, L. E. (1982). *Phosphorous*. In: Page, A. L., Miller, R. H. & Keeney, D. R. (eds.). Methods of soil analysis, part 2, Chemical and Microbiological properties, American Socie. of Agro. Inc. Madison, WI, USA, 403-430.
16. Shree S, Singh VK, Kumar R. Effect of integreated nutrient management on yield and quality of cauliflower (*Brassica oleracea* var. *botrytis* L.). The Bioscan 2014;9(3):1053-1058.
17. Noor, S., Farid, A. T. M., Shil, N. C. & Sultan, S. (2005). Evaluation of some organic manure on the yield of cabbage under integrated nutrient management system. Bangladesh J. Agric. and Envir. 1(2), 53-59.
18. Tibbett, M.; Green, L.; Rate, A.; De Oliveira, V.H.; Whitaker, J. The transfer of trace metals in the soil-plant-arthropod system. Sci.Total Environ. 2021, 779, 146260.
19. Tindall, M. (2000). Mineral and organic fertilizing in cabbage. Residual effect for commercial cultivation on yield and quality performance with organic farming. *Hort. Bras.* 6, 15-20.
20. Thomas, G. W. (1982). *Exchangeable cations*. In: A.L. Page (ed.). Methods of soil analysis. Part 2: Chemical and microbiological properties (2nd ed.). American Society of Agronomy, Soil Science Society of America. 9. pp. 159-165.
21. Tripathi, D.K.; Singh, S.; Singh, S.; Mishra, S.; Chauhan, D.K.; Dubey, N.K. Micronutrients and their diverse role in agricultural crops: Advances and future prospective. Acta Physiol. Plant. 2015, 37, 139.
22. Walker, D. J. & Bernal, M. P. (2004). Plant mineral nutrition and growth in a saline Mediterranean soil amended with organic wastes. Commun. Soil Sci. Plant Anal. 35(17-18), 2495–2514. http://dx.doi.org/10.1081/LCSS-200030347.