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Influence of Phosphorus Fertilizer Application and Foliar Spray with Phosphorein and Seaweed Extract on Chemical Content of Red Cabbage

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ABSTRACT

The experiment was conducted at Experimental Farm, Faculty of Technology and Development (Ghazala Region): Zagazig University Sharkia Governorate, Egypt during the winter seasons of 2021-2022 and 2022-2023, Egypt to study the effect of phosphorus fertilizer application at (50kg/fed and 100kg/fed) and foliar spray with phosphorein (bio-fertilizer) at ($2ml l^{-1}$ and $4ml l^{-1}$) and seaweed extract and seaweed extract on chemical content(the nutritive value) of red cabbage plant cv Primero. The treatments were arranged in a randomized complete block design (RCBD) with three replications. The obtained results revealed that added phosphorus at 100 kg/fed and foliar spray with phosphorein at 4ml/l or seaweed extract at 4ml/l significantly increased the nutritive value; N, P , K, anthocyanin pigment ,TSS and ascorbic acid (vitamin C) contents of red cabbage heads in the first and second seasons, respectively.

Conclusion: Added phosphorus at 100 kg/fed and foliar spray with phosphorein at 4ml/l and seaweed extract at 4ml/l caused an increases in the nutritive value; N, P, K, anthocyanin pigment, TSS and ascorbic acid (vitamin C) contents of red cabbage heads.

Key words: red cabbage , phosphorus , phosphorein, seaweed extract - chemical content

INTRODUCTION

Red Cabbage (*Brassica oleracea* L. var. capitata f. rubra DC.) is an excellent source of the antioxidants, glucosinolates, anthocyanin, vitamin C (ascorbic acid): and polyphenols, are helpful for the human immune system (Leja *et al.,* 2007). The nitrogen (N) content of cabbage are necessary for a greater chemical composition (Din *et al.,* 2007 ;Abd El-Rehem and Abd El-Baky, 2009).

Phosphorus (P): is an essential macronutrient, plays a vital role in growth and development of plants and their chemical content (Gupta *et al.,* 2018).

The importance of using biofertilizers is to reduce the amount and cost of chemical fertilizers and to eliminate environmental pollution, (Abd El Fattah, 1998). Biofertilizers are generally capable of inducing beneficial effect on a compatible host based on altering the rhizospher flora, by seed or soil inoculation with certain organisms. Biofertilizers mainly comprise phosphate dissolvers or Vesicular Arbuscular Mycorrhizae (VAM). These organisms may affect their host plant by one or more mechanisms such as nitrogen fixation, production of growth promoting substance or organic acids, enhancing nutrients uptake or protection against pathogens. Where the plants receiving phosphorein inoculation were significantly increased N, P and K % in plants over than uninoculated control plants (Khater, 2001)

Therefore, the purpose of the present study was to investigate the effect of phosphorus fertilization and foliar spray with phosphorein and seaweed extracts on quality of red cabbage.

MATERIALS AND METHODS

Field experiment was carried out during the successive winter seasons of 2022 and 2023 at the Experimental Farm, Faculty of Technology and Development, (Ghazala Farm): Zagazig University, Sharkia Governorate, Egypt to effect of phosphorus fertilization and foliar spray with phosphorein on yield quality of red cabbage plant.

Presented in Tables (1): and the analysis were performed according the methods described by Black (1982) and A.O.A.C. (2005): respectively.

Table (1): The characteristics of the experimental soil**.**

Analysis	2022	2023
Particle size distribution ($g.kg^{-1}$)		
Coarse sand	21	23
Fine sand	10	11
Silt	23	22
Clay	45	46
Mixture soil	Clay	Clay
Bulk density ($g.cm^{-3}$)	1.32	1.40
EC ($dS.m^{-1}$) in soil paste extract	2.76	2.77
pH (in 1 soil:2.5 water suspension)	8.2	8.3
Organic Matter (%)	1.66	1.67
Plant nutrients –available ($mg.kg^{-1}$)		
N	27.18	27.20
P	18.23	18.25
K	177.12	178.12
Si	27.02	28.02

EC = Electric conductivity

The experiments were set out in a randomized complete block design (RCBD) with three replications. The experiment included 11 treatments as follows:

1- Control (sprayed with tap water)

2- phosphorus at 50kg/fed

3- phosphorus at 100kg/fed

4- phosphorus at 50kg/fed+ phosphorein at $2ml l^{-1}$

5- phosphorus at 50kg/fed+ phosphorein at $4ml l^{-1}$

6- phosphorus at 100kg/fed+ phosphorein at $2ml l^{-1}$

7- phosphorus at 100kg/fed+ phosphorein at $4ml l^{-1}$

8- phosphorus at 50kg/fed+ Seaweed extract at 2 $ml l^{-1}$

9- phosphorus at 50kg/fed+ Seaweed extract at 4 $ml l^{-1}$

10- phosphorus at 100kg/fed+ Seaweed extract at 2 mll^{-1}

11- phosphorus at 100kg/fed+ Seaweed extract at 4 mll^{-1}

All plots of the experiment were received nitrogen as ammonium sulphate (20.6%) and Potassium as potassium sulphats (48% K_2O): at 100kg/fed at two equal quantities at 30 and 60 days of plant old. While, Phosphorus as calcium super-phosphate (16.5% P_2 O_5) at 100kg/fed was added at the treatments need that at two equal portions at soil preparation and 30 days of plant old, respectively, as well as, biofertilizer ; phosphorein and seaweed extract (biostimulant) as foliar application at three times ; 30 , 45 and 60 days of plant old..

Each experimental plot areas was 9.6 m^2 consisted of three ridges which each ridge was 0.8 m in width and 4 m in length.

The Primero cv. seeds of red cabbage were planted in nursery on the 15 and 17 of July month and transplanted at 15 and 17 September in both seasons of 2022 and 2023, respectively. The transplants were sown 25 cm distances between them on ridge.

The normal cultural treatments of growing and irrigation of garlic plant were followed as the recommend and occupied sowing by the Ministry of Egyptians Agriculture.

Data recorded

At harvest time, for data collection, three plants were randomly selected from each experimental units to measure:

Chemical Constituents (the nutritive value)

1- N, P and K percentages were estimated in the head of red cabbage using the method described by A.O.A.C. (2012) .

2- Anthocyanin content was determined according to Estefan *et al.* (2013).

3- Vitamin C (ascorbic acid) content and crude fibers were estimated in head according to the method reported in A.O.A.C. (2012).

4. Total soluble solids (TSS):

Samples taken especially for chemical contents, the full-ripe fruits were blended and filtrated through muslin cloth and then through filter paper No. 1, consequently the total soluble solids was determined in the filtrate by using Culr Zeis refractometer.

Statistical analysis

All the data were subjected to statistical analysis of variance according to the methods described by Snedecor and Cochran,1991.The means between the treatments were done by Duncan multiple range test (Duncan, 1955) of probability with the SAS software (SAS Institute, 2001).

RESULTS AND DISCUSSION

Chemical constituents(the nutritive value)

Data in Tables 2 and 3 show that , there were a significant differences between all rates of phosphorus application and foliar spray with phosphorein and seaweed extract significantly increased on total soluble solids (TSS): vitamin C content , anthocyanin content .N and P as well as K on red cabbage plants compared to control treatment in both seasons.

The combination of the highest phosphorus rate (100kg/fed) and the elevated concentration of phosphorein or seaweed extract at 4mll as foliar spray consistently achieved the highest values for all evaluated traits. This superior treatment recorded a maximum values for NPK contents, total soluble solids, Vitamin C, and anthocyanin content in the first and second seasons, respectively.

According to **Baldania (2023)** cleared that the treatment of seaweed provides the highest value of Vitamin C and attributed this increase in ascorbic acid might be due to presence of microelements and plant growth regulators , especially cytokinin present in seaweed extract. It helps to increase the enzymatic activity of plants due to the application of seaweed extract. **Lola *et al*. (2014)** suggested that increased phenolic content may be related to osmatic stress or increased plant hormone activity. Also, results are generally, agreement with that repotted by **Kałużewicz *et al.* (2017).** It also contains macronutrients (N, P and K) which are very essential for growth and development of the plant (**Attememe, 2009)**.

The organisms in phosphorein (biofertilizer) may affect their host plant by one or more mechanisms such as nitrogen fixation, production of growth promoting substance or organic acids, enhancing nutrients uptake or protection against pathogens. Where the plants receiving phosphorein inoculation were significantly increased N, P and K % in plants over than without an inoculated control plants **(Khater , 2001)**

Due to expanded dosage of phosphorus which might have been utilization of more soil physical condition and plant root framework was successfully impact to extend TSS and protein substance in handle, essentially the phosphorus supplements through basically expanded nitrogen, phosphorus and zinc substance in handle and clears out. It is an built up truth that phosphorus take-up by edit depends essentially on root and quality in handle aggregation. The impact of phosphorus and great soil physical condition through well created root framework is good for formation of plant quality (Yongji *et al.,* 1999).

These results are harmony with those reported by **Saravanan *et al*. (2003): Nour, *et al*. (2010) and El-Sheikh *et al*. (2020)** , they showed that spraying plants with SWE gave the highest values of all plant growth parameters of plants than unsprayed plants. As well as, **Khater (2001) , Shalan *et al.* (2001) Patel *et al.*(2018) and Singh *et al.* (2019),** they indicated that biofertilizer significantiy increased chemical contents of cabbage plants.

Conclusion: Added phosphorus at 100 kg/fed and foliar spray with phosphorein at 4ml/l and seaweed extract at 4ml/l caused an increases in the nutritive value; N, P , K ,anthocyanin pigment ,TSS and ascorbic acid (vitamin C) contents of red cabbage heads**.**

Table (2): Effect of phosphorus fertilization and foliar spray with phosphorein and seaweed extract on total soluble solids (TSS): vitamin C content and anthocyanin content of red cabbage during 2022/2023 and 2023/2024 seasons

Treatment	Vitamin C (mg/100ml)		TSS%		Anthocyanin(mg/1000ml)	
	2022-2023	2023-2024	2022-2023	2023 -2024	2022 - 2023	2023- 2024
T1	25.02g	24.32g	4.50d	5.06c	0.120f	0.226e
T2	28.54f	26.84f	5.20cd	5.30bc	0.145f	0.191e
T3	29.68e	28.60e	5.33cbd	5.66bc	0.220fe	0.236e
T4	29.50e	29.00e	5.33cbd	5.66bc	0.530bc	0.540dc
T5	30.00d	30.55e	6.33cb	7.00bc	0.355de	0.303e
T6	32.00c	33.00d	6.00cb	6.66bc	0.431dc	0.467d
T7	33.00c	34.00c	9.33a	6.33bc	0.672ab	0.543dc
T8	34.32b	34.40c	6.33cb	8.00ab	0.673ab	0.664bc
T9	34.43b	34.50c	6.66b	7.00bc	0.678ab	0.760ab
T10	36.00 a	36.01 b	6.66b	8.00ab	0.766a	0.813a

T11	36.20 a	37.20a	9.33 a	10.66a	0.800a	0.834a

T1: Control (sprayed with tap water):T2: phosphorus at 50kg/fed, T3: phosphorus at 100kg/fed, T4: phosphorus at 50kg/fed+ phosphorein $2ml^{-1}$, T5: phosphorus at 50kg/fed+ phosphorein $4ml^{-1}$,T6: phosphorus at 100kg/fed+ phosphorein $2ml^{-1}$, T7: phosphorus at 100kg/fed+ phosphorein $4ml^{-1}$,T8: phosphorus at 50kg/fed+ Seaweed extract $2ml^{-1}$,T9: phosphorus at 50kg/fed+ Seaweed extract $4ml^{-1}$,T10: phosphorus at 100kg/fed+ Seaweed extract $2ml^{-1}$,T11: phosphorus at 100kg/fed+ Seaweed extract $4ml^{-1}$

Means within a row followed by different letter (s) are statistically different using the Duncan Multiple Range Test at 0.05 level of probability.

Table(3): Effect of phosphorus fertilization and foliar spray with phosphorein on N, P and K content of red cabbage during 2022/2023 and 2023/2024 seasons

Treatment	N%		P%		K%	
	2022-2023	2023-2024	2022-2023	2023- 2024	2022- 2023	2023- 2024
T1	1.14e	1.073f	0.217d	0.89a	2.99f	3.14g
T2	2.15d	2.05e	0.243dc	0.24b	3.20e	3.20gf
T3	2.46cd	2.48c	0.240dc	0.25b	3.25ed	3.31de
T4	2.44b	2.54bc	0.240dc	0.24b	3.30dc	3.27fe
T5	2.46b	2.49c	0.243dc	0.24b	3.13e	3.34dce
T6	2.44b	2.43dc	0.234dc	0.24b	3.43bc	3.41dc
T7	2.92a	2.86a	0.305b	0.28b	3.56ab	3.45c
T8	2.22cd	2.23de	0.255c	0.28b	3.27d	3.45c
T9	2.35cb	2.36dc	0.232dc	0.34ab	3.27d	3.64b
T10	2.52b	2.50bc	0.229dc	0.35ab	3.31dc	3.73ab
T11	2.97a	2.77ab	0.348	0.37ab	3.67a	3.81a

T1: Control (sprayed with tap water):T2: phosphorus at 50kg/fed, T3: phosphorus at 100kg/fed, T4: phosphorus at 50kg/fed+ phosphorein $2ml^{-1}$, T5: phosphorus at 50kg/fed+ phosphorein $4ml^{-1}$,T6: phosphorus at 100kg/fed+ phosphorein $2ml^{-1}$, T7: phosphorus at 100kg/fed+ phosphorein $4ml^{-1}$,T8: phosphorus at 50kg/fed+ Seaweed extract $2ml^{-1}$,T9: phosphorus at 50kg/fed+ Seaweed extract $4ml^{-1}$,T10: phosphorus at 100kg/fed+ Seaweed extract $2ml^{-1}$,T11: phosphorus at 100kg/fed+ Seaweed extract $4ml^{-1}$

Means within a row followed by different letter (s) are statistically different using the Duncan Multiple Range Test at 0.05 level of probability.

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