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Response of Maize to Spraying Phosphorus and Seaweed under the Conservation Agriculture System

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ABSTRACT

*A field experiment was conducted during the fall season 2022 to study the Conservation agriculture system and the role of Treatment foliar sprays (phosphorus and seaweed) in improve growth and productivity of maize. The Randomized Complete Block Design (RCBD) within the order of split plots including three replicates was used. The experiment included two levels of Conservation agriculture (Zero Tillage or Tillage) symbolized by T0, T1, that represented the main plots, while the subplots included the foliar spray six mixtures of liquid phosphorus and seaweed: without spray (control), Full recommendation of di ammonium phosphate (DAP) symbolized (P1), Half-recommended di ammonium phosphate (DAP), with spraying liquid phosphorous at concentration of 100 ml/L symbolized (P2), Half-recommended di ammonium phosphate (DAP) with spraying liquid phosphorous at concentration of 200 ml/L symbolized (P3), Half recommended di ammonium phosphate (DAP) with spraying liquid phosphorus at concentration of 100 ml/L with seaweed at concentration of 50 ml/L symbolized (P4), and Half-recommended di ammonium phosphate (DAP) with liquid full-recommendation with 200 ml/L of with seaweed at concentration of 100 ml/L symbolized (P5). Results showed, Conservation agriculture negatively affected the vegetative growth characteristics, reduced Plant height and Leafy area, **Crop growth rate** Also, the characteristics of productivity were negatively affected, and the 500-Grains weight, decreased gave 77.81(g), and the Grain yield 3.18 (Mega ha). Foliar spraying improved and increased the growth characteristics and productivity of Maize, gave higher treatment (P5) for plant height and leaf area as well as the highest productivity. Conclude Conservation agriculture of Maize did not succeed in central Iraq and affected negatively in reducing the growth and productivity characteristics, and that foliar spraying led to improving and increasing the growth and productivity of Maize.*

Keywords

Foliar spray phosphorus, Zero tillage, Seaweed extract, Mize.

Introduction

Tillage is practice an effective farm activity to improve soil tilth and soil physical conditions [1]. Helps tillage, which increased nutrient use efficiency of crop and eventually leads to produce high biomass yield crop yield [2]. Numerous factors, such as diseases, seasonal changes, and irrigation hampered yield of maize but tillage is most imperative factor among them [3]. Tillage has activity also positive effect on soil organic matter [4]. Increase aeration of soil, organic nitrogen mineralization and availability of nitrogen to plants for use. Agricultural operations deposit a hard layer under the soil, which has negative impacts on root penetration, soil porosity and nutrient status, soil bulk density, which indirectly reduces a crop yield [5]. Deep plowing to a depth of (30 cm) is an effective method for breaking up a layer under compacted soil [6]. Organic matter, nitrogen contents, and exchangeable cation are positively influenced under as compared to the conventional tillage. Due to higher soil organic matter contents, soil physical and chemical properties improved and have significant positive effect on crop yield, the drastic problem of soil erosion can also be minimized by zero tillage [7]. It is well known that intensive tillage is associated negative environmental impacts, such as top soil erosion by use of heavy machinery [8]. Therefore, resource conservation technologies need to be introduced [9]. Recently no tillage is frequently used to mitigate soil erosion and loss of soil organic matter, moreover, earlier studies indicated that

conservation tillage gave higher yield as compared to the intensive tillage [10,11]. Humanity faces an unprecedented challenge in meeting growing demand for food and improving environmental sustainability [12]. Whilst adapting agriculture to an increased severity and frequency of climate stresses [13,14]. As such, we urgently need better evidence showing how cropping systems can adapt to climate stresses [15]. Conservation Agriculture is a one-adaptation option around three management principles: minimum mechanical soil disturbance, permanent soil organic cover, and crop species diversification through varied crop sequences and associations [16]. In addition to the three principles, the functioning of Conservation Agriculture can be enhanced by using good agricultural practices, some of which include planting stress tolerant crop varieties and appropriate nutrient supply [17]. The importance of the seaweed or what is called marine algae as a crop stimulant has been well documented. It was reported that there are many advantages of the seaweed extract for crop growth such as IAA and IBA acids as well as amino and acids and vitamins [18]. Phosphorus P is the second most growth-limiting factor for plant. Although soils contain adequate amount of P, however, plant available P remains low. Therefore, in most soils a good supply of P is important to ensure plant development. Despite numerous research on application method, source, and timing, P use efficiency remains low [19]. Plants uptake P as either H_2PO_4 – or H_2PO_4 2 orthophosphate ions and the availability of these ions depends on soil pH. Therefore, understanding the factors that affect P availability is essential for efficient P management. Therefor the aim of a current study was to investigate corn response to foliar application of (P) as an alternative to granular fertilizers, with seaweed growth stimuli.

Materials and Methods

A field experiment was carried out in Qazaniyah city/ Diyalaa province during a fall season, 2022. The field was arranged according to the order of Spilt-plots using the Randomized Complete Block Design (RCBD) with three replicates. The main plots were presented the treatments of Conservation Agriculture (Zero Tillage (T0) and Tillage (T1)) while, the subplots were contained six combinations from leaves spry, a liquid phosphorous, and seaweed which are, without spry (P0), the full recommendation of DAP (200 kg/ha) (P1) was added with sowing of maize seeds, a half recommendation of DAP (100 kg/ha) with spry of a liquid phosphorous (100 ml/L) (P2), a half recommendation of DAP (100 kg/ha) with spry of a liquid phosphorous (200 ml/L) (P3), a half recommendation of DAP (100 kg/ha) with spry of a liquid phosphorous (100 ml/L) with seaweed (50 ml/L) (P4), and a half recommendation of DAP (100 kg/ha) with spry of a liquid phosphorous (200 ml/L) with seaweed (100 ml/L) (P5).

The samples of soil were collected randomly from the field from the deep of 0-30 cm to analyze some of chemical and physical properties of soil (Table1). Soil service operations were carried out, including plowing, smoothing and leveling, while conservation agriculture was carried out directly without any tillage operations of the field soil, and the field was divided into experimental units of 2×3 m. The seeds of corn were sown on 7/25/2022 in rows using 70 cm between them, while the distance between plants was 20 cm. Nhreen corn hybrid which was derived by the Agricultural Research Office/Ministry of Agriculture/Iraq was used in current study. Field management operations were carried out periodically and continuously. The experimental units were fertilized according to the approved recommendation. Seaweed of Chinese origin known commercially as Combe Star was prepared with a content of 35% of Seaweed, while the element of phosphorus was used, as liquid fertilizer (known commercially as DAP). The solution of liquid fertilizer was prepared according to the required concentrations MAPCO DAP LIQUID (18-46-0). Spray treatments were applied in the evening on the vegetative part. The plants were treated with foliar spray at the V3 stage of the crop life, which is completed within 12 days of sowing [20]. Washing powder was added with liquid fertilizer to increase the surface tension. The field traits were studied as follows: plant height (cm), leaf area (cm^2), crop growth rate (gm $plant^{-1}$ day^{-1}): chlorophyll content (spad): Five randomly selected plants were selected from each experimental unit and calculated: the number of rows (row per ear), the number of grains in the row (grain row^{-1}), the weight of 500 grains (g), the total grain yield (ton/ha).

Table 1: Some physical and chemical properties for the study soil.

Properties	Units	Value	
EC	$ds.m^{-1}$	4.20	
pH		7.76	
Available N	mg. kg^{-1}	8.10	
Available P		6.0	
Available k		233	
Organic matter	mg. kg^{-1}	1.77	
Apparent density	$Meq.L^{-1}$	1.25	
Texture	Clay Loam Soil		
Soil texture	mg. kg^{-1}	Sand	150
		Clay	520
		Silt	360

Results

Growth traits

The results in Table 2 shows a significant effect of Conservation agriculture treatments on the traits: plant height, leaf area, and crop growth rate. During studied season. The treatment T1 (Tillage) recorded the highest plant height which were averaged at 185.31cm, whereas the treatment T0 (Zero tillage) recorded the lowest values of plant height at 171.39 cm. It was also observed from the table 2 that the T0 (Zero tillage) treatment recorded the lowest leaf area at 2986 cm2. That were less than the treatment T1 (Tillage) by 10.78% for the season. The table 2 results also refer to a decrease in crop growth rate which were affected by T0 (Zero tillage) treatments. The treatment T1 (Tillage) produced the highest values of crop growth rates (2.57 $g.plant^{-1}.day^{-1}$). In addition, T0 (Zero tillage) treatments lowest crop growth rate at 2.03 $g.plant^{-1}.day^{-1}$ in season.

Tables 2 refer the significant effect of foliar spray treatment on the traits: plant height, leaf area, and crop growth rate, during study season. The treatment Foliar spray (P5) produced the highest plant height (183.00 cm) and did not differ significantly from the

treatments (P4, P4, P3), and but it differed significantly from the control treatment (P0) achieving the lowest plant height in first and second seasons (171.33cm). The treatment Foliar spray also increased the leaf area where the treatment Foliar spray (P5) achieved the highest values of leaf area at 3330 cm^2, while the treatment (P3) recorded the value of this trait averaged at 3248 cm^2. On the other hand, the control treatment (P0) produced the lowest leaf area (2967 cm2) in season. The treatment (P4 P5) contributed significantly in increasing to crop growth rate to reach 2.68 $g.plant^{-1}$ and 2.63 $g.plant^{-1}.day^{-1}$ respectively. However, it was significantly different from the control treatment (P0) that achieved the lowest at 1.94 $g.plant^{-1}.day^{-1}$.

Content of chlorophyll

Table 2 shows a significant effect of Conservation agriculture treatments in effect on leaves content of chlorophyll, Where treatment T1 (tillage) achieved the highest average of the leaves content of chlorophyll at 38.91 (Spad), while the lowest average for treatment T0 (Zero tillage) treatment by 34.59 (Spad(. Foliar spray treatments had a significant effect on increased leaves content of chlorophyll, (P4) treatment achieved the highest average for leaves content of chlorophyll of 38.62 (Spad), compared with the treatment of without vaccination (P0) which gave the lowest average of 32.94 (Spad).

Grain yield components

Table 3 shows a significant effect of T1 (tillage) treatment on yield components, the T1 (tillage) gave the highest Number of rows per an ear and number of grains per a row behaved similarly, where the recorded the highest values of the traits with mean of 15.15 rows ear and 37.43 grains row in the season respectively, while the lowest averages were recorded by T0 (Zero tillage) at (12.92 rows ear and 33.19 grains row). The weight of 500 grains was reduced significantly in T0 (Zero tillage) giving the lowest average (77.81grains), while T1 (tillage) achieved the highest average of the trait. The Foliar spray treatments showed significant increase in Number of rows per an ear and number of grains per a row, Foliar spray P5 treatments giving 16.17 rows. Ear and 38.47 grains. Row in the season respectively. In addition, significantly superior to the control P0. The 500-grains weight, in Foliar spray treatments (P5) was superior in maximizing the trait average to 92.6 g in the season.

The interaction between the two factors was significant. The combination of T1with P5 recorded the highest number of grains and 500-grains weight (39.73 grains row, 94.75 g) in contrary to the combination (T0, P0) that gave the lowest number of grains (27.80 grains row on average, 62.73 g).

Grain yield

The T1 (tillage) treatment produced the highest yield of the grains (3.79 Mega ha), the contribution of the Foliar spray treatments (P5) significant in increasing the grain yield. The P5 significantly increased the grain yield to 3.95 Mega ha in the season; however, all treatments of them were significantly superior compared to the control.

Discussion

Recently The number of foliar P fertilizers available in the market has been increased, these products are registered as supplemental soil and foliar P fertilizers for crops, Because of the high cost of P and its lack of readiness, and the ease of application of foliar spray, and to increase use efficiency, to prevent P loss to water through runoff, that foliar spray application may replace phosphate fertilizer in some crops, therefore the aim of our study was to investigate corn response to foliar application of (P) solution that has been marketed as an alternative source of P, With seaweed growth stimuli or what is called marine algae for Corn under the conservation agriculture system.

Conservation agriculture is a field practice that combines non-reversible tillage, non-invertible tillage and is called zero tillage instead of tillage. Recently, the number of foliar fertilizers available in the market has increased, and these products, such as liquid P, have been registered as supplementary foliar fertilizers for crops, due to the high cost of phosphorus and its low readiness when added to most agricultural soils, while liquid P is characterized by its ease of spraying on leaves, and its increased efficiency. As well as, the lack of loss with water through surface runoff, sometimes, process of spraying on the leaves to may contribute to the replace part of the phosphate fertilizers. Therefore, the objective of the study was to investigate the response of maize to foliar application of (P) solution, which is marketed as an alternative source of phosphorus at different concentrations, with stimulants for the growth of seaweed or what is called seaweed for maize under the conservative cultivation system.

The results of the study shown in Tables (2 and 3) show that there is a negative impact on some of the growth traits of corn as a result of no-till treatments (conservative cultivation), including a decline in plant height, leaf area and crop growth rate. (1) As the loamy clay soil texture may impede the development of the roots of the crop at the beginning of growth, which need a good cradle for growth and development, and the low standards of crop growth in unplowed soil may be due to the compaction and cohesion of the soil and the decrease in the pores between them, and then the increase in bulk density As shown in Table (1). That is, plowing has a major role in increasing the interstitial pores in the dry turbine and reducing the pressure exerted on it by the layers through the passage of agricultural crops and machinery. Soil nutrients and water from the soil [21]. This is consistent with many researchers who have found increased growth parameters with plowed soils [22,23]. The weight of 1000 grains is the most important component of the grain yield, which is an important component that contributes to the grain yield, its components that are the end product of photosynthesis. The results in Table 3 indicated that the tillage process had a significant and negative effect on the number of grains in the ear (number of rows and number of grains per row). The increase and improvement of the components of grain yield and yield may be attributed to benefiting from the improvement of chlorophyll content and leaf area of the yield. On the other hand, tillage works on the availability of Nutrients in the topsoil, as tillage increases organic matter (OM) after a prolonged duration of

tillage. This is indicated by Wang et al. [24] that tillage improves OM in top soils by 31.2%. This is similar to what was found by [25] superiority of the tillage treatment compared to the no-till treatment. We must also not forget that the nature of the crop has a relationship and is linked to the success or lack of success of preservative agriculture, as yellow corn, which is characterized by very rapid growth after germination, which indicates that it must provide large amounts of nutrients close to the root zone for absorption, as well as an abundance of suitable cradle that does not deepen and grow Its roots and these features that are not available

Table 2: Effect of conservation agriculture and Treatment foliar sprays their interactions on Plant height (cm), Leaf area (cm^2), Crop growth rate ($g.plant^{-1}.day^{-1}$) and Chlorophyll content (Spad) in the autumn seasons of 2022.

Leaf area (cm^2)				**Plant height (cm)**			
Means	**conservation agriculture**		**Treatment foliar sprays**	**Means**	**conservation agriculture**		**Treatment foliar sprays**
	T1	**To**			**T1**	**To**	
2967	3037	2897	**P0**	**171.33**	176.67	166.00	**P0**
3050	3226	2875	**P1**	**175.28**	183.22	167.33	**P1**
3119	3265	2973	**P2**	**179.00**	184.00	174.00	**P2**
3248	3393	3104	**P3**	**179.17**	188.33	170.00	**P3**
3170	3310	3030	**P4**	**182.33**	189.33	175.33	**P4**
3330	3620	3040	**P5**	**183.00**	190.33	175.67	**P5**
148	**N.S**		**$L.S.D_{0.05}$**	**9.18**	**N.S**		**$L.S.D_{0.05}$**
	3308	2986	**Means**		185.31	171.39	**Means**
213			**$L.S.D_{0.05}$**	**4.77**			**$L.S.D_{0.05}$**
Chlorophyll content				**Crop growth rate ($g.plant^{-1}.day^{-1}$)**			
Means	**conservation agriculture**		**Treatment foliar sprays**	**Means**	**conservation agriculture**		**Treatment foliar sprays**
	T1	**To**			**T1**	**To**	
32.94	34.38	31.50	**P0**	**1.94**	2.13	2.60	**P0**
36.49	41.64	31.33	**P1**	**2.18**	2.66	2.67	**P1**
37.22	39.10	35.33	**P2**	**2.22**	2.64	1.71	**P2**
37.00	38.50	35.50	**P3**	**2.18**	2.65	1.79	**P3**
38.62	40.83	36.40	**P4**	**2.68**	2.69	1.66	**P4**
38.25	39.00	37.50	**P5**	**2.63**	2.66	1.75	**P5**
1.91	**2.56**		**$L.S.D_{0.05}$**	**0.13**	**0.18**		**$L.S.D_{0.05}$**
	38.91	34.59	**Means**		2.57	2.03	**Means**
1.48			**$L.S.D_{0.05}$**	**0.16**			**$L.S.D_{0.05}$**

Table 3: Effect of conservation agriculture and Treatment foliar sprays their interactions on number of rows per an ear ($rows.ear^{-1}$), number of grains per a row ($grains\ row^{-1}$),and 500-grains weight (g) in the autumn seasons of 2022.

Number of grains per a row (grains row)				**Number of rows an ear^{-1}(rows, ear)**			
Means	**conservation agriculture**		**Treatment foliar sprays**	**Means**	**conservation agriculture**		**Treatment foliar sprays**
	T1	**To**			**T1**	**To**	
32.33	36.87	27.80	**P0**	11.73	13.64	9.81	**P0**
33.85	36.93	30.77	**P1**	13.60	15.30	11.90	**P1**
35.08	36.53	33.63	**P2**	13.45	14.97	11.93	**P2**
34.37	37.30	31.43	**P3**	13.83	15.33	12.34	**P3**
37.77	37.20	38.33	**P4**	15.43	15.33	15.53	**P4**
38.47	39.73	37.20	**P5**	16.17	16.33	16.00	**P5**
2.53	**3.33**		**$L.S.D_{0.05}$**	**1.133**	**1.464**		**$L.S.D_{0.05}$**
	37.43	33.19	**Means**		15.15	12.92	**Means**
1.47			**$L.S.D_{0.05}$**	**0.148**			**$L.S.D_{0.05}$**
grain yield (Mega ha)				**500-grains weight (g)**			
Means	**conservation agriculture**		**Treatment foliar sprays**	**Means**	**conservation agriculture**		**Treatment foliar sprays**
	T1	**To**			**T1**	**To**	
3.00	3.30	2.70	**P0**	76.29	89.84	62.73	**P0**
3.33	3.83	2.83	**P1**	85.23	94.58	75.88	**P1**
3.38	3.60	3.16	**P2**	84.00	93.55	74.45	**P2**
3.58	3.90	3.26	**P3**	83.65	92.53	74.77	**P3**
3.68	3.96	3.40	**P4**	86.07	83.74	88.40	**P4**
3.95	4.16	3.73	**P5**	92.67	94.75	90.60	**P5**
0.17	**0.22**		**$L.S.D_{0.05}$**	**2.56**	**4.54**		**$L.S.D_{0.05}$**
	3.79	3.18	**Means**		91.50	77.81	**Means**
0.08			**$L.S.D_{0.05}$**	**5.55**			**$L.S.D_{0.05}$**

when no tillage may hinder its growth and development. Unlike other crops with slow growth and roots close to the soil surface, such as wheat. The application of foliar spray treatments of phosphorus and algae extract freely contributed to improving the characteristics of vegetative growth and chlorophyll content. The results of tables (2 and 3) indicate that the phosphorus spraying treatments increased the growth parameters, and this is due to most of the nutrients being absorbed by leaves and stems through stomata when the environmental conditions are appropriate. Therefore, the absorption of phosphorus by the leaf was sufficient and encouraging to increase plant height and leaf area, as well as it is considered one of the most important inputs in the production of chlorophyll. This does not mean that the foliar spray compensates or provides a sufficient amount of phosphorus when the deficiency is high or without adding granular phosphorus, but rather it represents a supplement with the prepared liquid. In addition, the application of spraying algae freely contributed significantly to increasing growth and productivity traits, because it contains many growth regulators such as cytokinins that can promote crop growth, and thus, [26]. It can also be treated with marine algae, which may contribute to increasing the yield and components of maize due to its nutritional content. Micronutrients such as Ca, Cu, Zn, Fe, B, and Mn are also important components of seaweed extract [27,28].

Conclusion

Results shows the application of conservation agriculture with maize did note succeed and was impractical in the conditions of central Iraq and gave negative results in declining growth and productivity characteristics, while Tillage soil that improved growth and productivity, and that foliar spraying improved and increased growth and productivity of maize.

References

1. Khan NI, AU Malik, F Umer, et al. Effect of tillage and farm yard manure on physical properties of soil. Int Res J Plant Sci. 2010; 1: 75-82.
2. Bahadar KM, M Arif, MA Khan. Effect of tillage and zinc application methods on weeds and yield of maize. Pak J Bot. 2007; 39: 1583-1591.
3. Rosner J, E Zwarts, A Klik, et al. Conservation tillage systems-soilnutrient and herbicide loss in lower Austria and the Mycotoxin problem, 15th International Congress of ISCO 18-23 May 2008, Budapset. Publ Geog Res Inst Hungary. 2008.
4. Tian S, T Ning, Y Wang, et al. Crop yield and soil carbon responses to tillage method changes in North China. Soil Till Res. 2016; 163: 207-213.
5. Ahmad N, FU Hassan, RK Belford. Effect of soil compaction in the sub-humid cropping environment in Pakistan on uptake of NPK and grain yield in wheat. Field Crops Res. 2009; 110: 54-60.
6. Hou X, R Li, Z Jia, et al. Effects of rotational tillage practices on soil properties, winter wheat yields and wateruse efficiency in semi-arid areas of north-west China. Field Crops Res. 2012; 129: 7-13.
7. Karina MVC, APD Silva, CA Tormena, et al. Long-term effects of no-tillage on dynamic soil physical properties in a Rhodic Ferrasol in Parana, Brazil. Soil Till Res. 2009; 103: 158-164.
8. Gupta, R.K., G.C. Fernando, S. Paliwal, S.V.K.R. Parbhakar and A. Srivastava. 2002. Maize in the rice-wheat rotation of Indo-Gangetic plains. In: Proc. Eighth Asian Reg. Maize Workshop, August 5-8. Bangkok, Thailand. 2013; 205-213.
9. Safeer A, I Aziz, T Mahmood, et al. Influence of different tillage practices and earthworm on selected soil physio-chemical parameter and yield of maize. Soil Environ. 32: 114-120.
10. Zhanga S, X Chena, S Jiaa, et al. The potential mechanism of longterm conservation tillage effects on maize yield in the black soil of Northeast China. Soil Till Res. 2015; 154: 84-90.
11. Shao Y, Y Xie, C Wang, et al. Effects of different soil conservation tillage approaches on soil nutrients, water use and wheat-maize yield in rainfed dry-land regions of North China. Europ J Agron. 2016; 81: 37-45.
12. Godfray HCJ, Garnett T. Food security and sustainable intensification. Philosoph Trans Royal Soc Lond B Biol Sci. 2014; 369.
13. Challinor AJ, Watson J, Lobell DB, et al. A meta-analysis of crop yield under climate change and adaptation. Nat Clim Chang. 2014; 4: 287-291.
14. Thornton PK, Ericksen PJ, Herrero M, et al. Climate variability and vulnerability to climate change: a review. Glob Chang Biol. 2014; 20: 3313-3328.
15. Conway D, Nicholls RJ, Brown S, et al. The need for bottom-up assessments of climate risks and adaptation in climate-sensitive regions. Nat Clim Chang. 2019; 9: 503-511.
16. FAO. Conservation Agriculture. Food and Agriculture Organization of the United Nations, Rome. 2019.
17. Thierfelder C, Baudron F, Setimela P, et al. Complementary practices supporting conservation agriculture in southern Africa. A review Agron Sustain Dev. 2018; 38: 16.
18. Salim BBM. Influence of biochar and seaweed extract applications on growth, yield and mineral composition of wheat (Triticum aestivum L.) under sandy soil conditions. Annals of Agricultural Sciences. 2016; 61: 257-265.
19. Raun WR, H Zhang. Oklahoma soil fertility handbook. Stillwater, OK: Department of Plant and Soil Sciences, Oklahoma State University. 2006.
20. Bell J. Corn growth stages and development. 2017.
21. Anjum SA, Raza MM, Ullah S, et al. Influence of different tillage practices on yield of autumn planted maize (Zea mays L.). Pakistan Journal of Agricultural Research. 2019; 32: 293-301
22. Vetsch JA, GW Randall. Corn production as effected by tillage systems and starter fertilizer. Agron J. 2002; 96: 502-509.
23. Wasaya A, M Tahir, A Manaf, et al. Improving maize productivity through tillage and nitrogen management. Afr J Biotech. 2011; 10: 19025-19034.

24. Wang Q, Lu C, Li H, et al. The effects of no-tillage with subsoiling on soilproperties and maize yield: 12-Year experiment on alkaline soils of northeastChina. Soil Tillage Res. 2014; 137: 43-49.
25. Shao Y, Y Xie, C Wang, et al. Effects of different soil conservation tillage approaches on soil nutrients, water use and wheat-maize yield in rainfed dry-land regions of North China. Europ J Agron. 2016; 81: 37-45.
26. Kumar G, Sahoo D. Effect of seaweed liquid extract on growth and yield of Triticum aestivum var. Pusa Gold. Journal of Applied Phycology. 2011; 23: 251-255.
27. Khan W, Rayirath UP, Subramanian S, et al. Seaweed extracts as biostimulants of plant growth and development. Journal of Plant Growth Regulation. 2009; 28: 386-399.
28. Team RC. R: A language and environment for statistical computing (R Version 4.0. 3, R Foundation for Statistical Computing, Vienna, Austria. 2021.