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SOME MAIZE LEAF GROWTH TRAITS AS INFLUENCED BY SOME INTEGRATED FERTILIZATION REGIMES

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ABSTRACT: A field experiment was conducted at the summer season of 2017, and then repeated at the summer season of 2018 in Agricultural Research Station. Faculty of Agric., Zigzag Univ., Sharkia Governorate, Egypt. The study investigated the impact of eleven nitrogen and five phosphorus fertilization regimes on some leaf traits 70 days after sowing (DAS) of maize cultivar single hybrid 168. Results showed that, 120kg N/fad., from different sources *i.e.*, chemical fertilizer, compost and biofertilizers were effectless on number of leaves/plant at 70 days after sowing (DAS) of both seasons and their combined analysis. Number of leaves either under or above the ear of mono eared maize plant were not affected due to applying different nitrogen fertilization regimes studied. Leaf area/maize plant was significantly affected in the first season only. The largest leaf erea/plant (4254.22 cm2/plant) was obtained in the first season, with the appliance of the integrated N fertilization regime (90 kg N from chemical fertilizer +30 kg N from compost). Area of leaves under ear resulted from the integrated fertilization regime (cerealine + 60 kg chemical N+ 60 kg N from compost) was larger than that in the control treatment by 30.94% based on combined results. Regarding to the area of leaves above the ear, results of the 1st season displayed that area of leaves above the ear were at par in treatments N_2, N_3, N_4, N_5 and N_6. Application of either 120kg chemical fertilizer (N_2) or 90 kg chemical N +30 kg N from compost (N_3) was conjucated with larger values of leaf area index comparably with other regimes. According to combined analysis, ear leaf area ranged from 481.87 cm^2 in control treatment to 625.89 cm^2 in the integrated nitrogen fertilization regimes comprised of cerealine + 60 kg chemical N/fad. + 60 kgN from compost. From the results of combined analysis, it could be noted that tassel leaf area ranged between 150.99 to 217.87 cm^2 under biofertilization (N_{11}) and the integrated fertilization regimes (N_8) in the same order. Insignificant phosphorus fertilization effect under study on maize leaf traits studied at 70DAS, was recorded in both seasons and the combined analysis.

Key words: Nitrogen, phosphorus, integrated fertilization regimes, maize leaf traits.

INTRODUCTION

Maize ranked third among the world cereal crop production **(Majid *et al*., 2017)**. Maize is grown for grain as well as fodder in tropical, sub-tropical and temperate regions of the world **(Kumar and Jhariya, 2013)**. Maize, has multiple uses such as bread making, corn syrup, corn flakes, corn starch and fuel production (ethanol and corn oil diesel). Maize is one of the most important cereal crops in summer season in Egypt, it ranks third after wheat and rice. Corn imports in marketing years (MY) 2018/2019 are forecast at 9.5 MMT **(GAIN Report, 2018)** FAS Cairo forecasts Egypt's corn production in (MY) 2018/2019 at 6.8 million metric tons (MMT). Planted area reached 850,000 hectares in 2018/2019, reportedly white corn planted area accounts for 600,000 hectares, the residual area was planted with yellow corn **(GAIN Report, 2018)**.

Nitrogen is one of the essential nutrients for plants and their practical management as a major element of intensive crop production. Nitrogen absorbed adequately increases photosynthesis, vegetative growth and eventually high yield.

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Increased use of synthetic N-fertilizers have led to pollution of the environment and destroyed micro-organisms, caused the plants more prone to diseases and reduced soil fertility **(Khattab *et al.*, 2016)**. Free living N_2 -Fixing bacteria are soil microbes widely used as bio-fertilizer, binds atmospheric nitrogen release it into the soil as ammonium ions form **(Mahato and Neupane, 2017)**. Cerealine is a commercial product of nitrogen bio-fertilizer contains free living N_2-Fixing bacteria (*Azospirillum brasilense* and *Bacillus polymyxa*) was used in this study. Compost is a mixture of organic residues. Composted organic material can be used as a source of important nutrients for sustainable crop production **(Amanullah *et al.*, 2015).** Application of compost at sowing improved maize yield and its components **(Amanullah and Khan, 2015; Kamran *et al.*, 2018).** Phosphorus ranked second as plant essential nutrient affecting plant growth by inducing the basic metabolic processes **(Khan *et al.*, 2014; Fazalullah *et al.*, 2018)**.The recapture efficacy of P is less than 20% of the added P in the world soil **(Qureshi *et al.*, 2012)**. In fact, the P fertilizer utilization is less than 30% because soluble P is quickly fixed by reacting with free Al^{3+}, Ca^{2+}, Mg^{2+} and Fe^{3+} upon its application in the soil **(Sharma *et al.*, 2013)**. Phosphate solubilizing bacteria (PSB) inoculation reduce or may minimize application of chemical P fertilizers up to 100% under exist soil and climatic conditions **(Fazalullah *et al.*, 2018)**. Phosphorien, is a commercial PDB contains *Bacillus megatherium var phosphaticum* was used in this investigation. There is an urgent need for integrated management of fertilizers that are applied to the soil as agricultural inputs to reduce the adverse environmental impacts of chemical fertilizers. This investigation was performed to study the impact of integrated management of some nitrogen and phosphorus fertilizer regimes on some leaf traits of maize cultivar single hybrid 168.

MATERIALS AND METHODS

A field experiment was conducted at the summer season of 2017 then repeated at the summer season of 2018 in the Agricultural Research station, Faculty of Agriculture, Zagazig University, Ghazal Farm. Sharkia Governorate, Egypt. The investigation studied the effect of eleven nitrogen and five phosphorus fertilization regimes on some leaf traits, 70 days after sowing (DAS) of the maize cultivar (single hybrid 168 (*Zea maize*)). Nitrogen fertilization regimes (N) are presented in Table 1.

Table 1. Nitrogen fertilization regimes

Treatment	Nitrogen from chemical fertilizer (kg/fad.)	Nitrogen from compost (kg/fad.)	Bio-fertilizer cerealine	Total nitrogen (kg/fad.)
N_1	Control	-	-	-
N_2	120	-	-	120
N_3	90	30	-	120
N_4	60	60	-	120
N_5	30	90	-	120
N_6	-	120	-	120
N_7	90	30	Cerealine	120
N_8	60	60	Cerealine	120
N_9	30	90	Cerealine	120
N_{10}	-	120	Cerealine	120
N_{11}	-	-	Cerealine	-

Phosphorus fertilization regimes (P) included five treatments *i.e.* P_1 (control), P_2 (45kg P_2O_5/ fad.), P_3 [30 kg P_2O_5/fad. + Phosphorien (1 package = 600 g)], P_4 [15 kg P_2O_5/fad. + Phosphorien (2 packages = 1200g)], P_5 [Phosphorien (3 packages=1800g)].

Chemical and biological fertilizers used

Urea (46.5%N) as chemical nitrogen fertilizer was used to detect nitrogen fertilizer regimes. Regimes which included adding chemical N fertilizer, and regardless its amount, fertilizer was split into three equal doses which applied at sowing, 20days after sowing (DAS) and 35 DAS. The amount of the commercial fertilizer (Urea) was calculated according to each nitrogen level in nitrogen fertilization treatments (N_2, N_3, N_4, N_5, N_7, N_8, N_9). Respecting biological nitrogen fertilizers, a commercial bio-fertilizer (Cerealine) as a free living nitrogen fixing bacteria (*Azotobacter* sp. + *Azospirillum* sp.) was used at the rate of 700g/seed/fad. Inoculation by Cerealine was done by mixing with maize kernels with the aid of Arabic gum 5% as sticking substance, just before planting. The amount of compost was calculated according to each nitrogen level in fertilization treatments (N_3, N_4, N_5, N_6, N_7, N_8, N_9, N_{10}). As for phosphorus fertilization regimes, calcium superphosphate (15.5% P_2O_5) as chemical fertilizer was supplied at sowing, whereas, the amount was determined based on each phosphorus level in treatments (P_2, P_3 and P_4). Phosphate dissolving bacteria (PDB) contains *Bacillus megatherium var phosphaticum*, is an Egyptian bio-fertilizer commercially named (Phosphorien) used in detecting P_3, P_4 and P_5. Biofertilizers used in this study (Cerealine and Phosphorien) were produced by General organization for the Agricultural Equalization Fund (GOAEF), Ministry of Agriculture, Egypt. Compost is commercially produced by Al Arabia for organic Composition, Sharkia Governorate Egypt. Nitrogen (%) in the compost was 1%as reported in the chemical analysis of compost samples.The amount of compost [based on N (%)] was calculated according to each treatment (see Table 1). Compost was added at sowing. A split -plot design with three replicates was performed in the two seasons, nitrogenous fertilization regimes were allotted to the main plots, phosphorus fertilization treatments occupied the sub-plots. Area of each sub-plot was $15m^2$, included 6 ridges. The preceding crop was wheat in both seasons, maize seeds were sown in hills, 25cm apart with 80cm space between ridges. Sowing took place on 20^{th} May during two summer seasons in 2017 and 2018, while the harvest was done 105 DAS in both seasons.

At 70 DAS five maize guarded plants were randomly taken from the 2^{nd} ridge of each experimental unit, and the following traits were determined:

1. Number of leaves/plant.
2. Number of leaves under the ear/plant.
3. Number of leaves above the ear/plant.
4. Leaf area (cm^2 /plant), which was measured according to **McKee (1964)** as follows:

Leaf area = leaf length × leaf width × 0.75,

Leaf area (cm^2 /plant)=Average leaf area of ten leaves × Average number of leaves/plant.

5. Area of leaves under the ear(cm^2)
6. Area of leaves above the ear(cm^2)
7. Leaf area index(LAI), it was calculated according to **Watson (1952)** as follows

LAI= Leaf area (cm^2/plant) ÷ land area (cm^2)

8. Ear leaf area(cm^2)
9. Tassel leaf area (cm^2)

Data recorded were analyzed using analysis of variance based on a split-plot design according to procedures outlined by **(Snedecor and Cochran, 1967)** mean comparisons were done using least significant difference (LSD) according to (**Duncan, 1955**).

RESULTS AND DISCUSSION

Number of Leaves/Plant

Table 2 shows the results concerning the impact of nitrogen and phosphorus fertilization regimes on number of leaves/maize plant, 70 DAS.

Table 2. Effect of nitrogen and phosphorus fertilization regimes on number of leaves/plant (70 DAS) of maize plant in 2017 and 2018 seasons

Main effects and interaction	Number of leaves/ plant		Comb.
	2017	2018	
Nitrogen fertilization regimes(A)			
N_1-Control	10.82	13.66	12.24
N_2-120Kg chemical N/fad .	11.80	13.74	12.77
N_3 -90Kg chemical N/fad.+ 30 kg N (Compost)	11.13	12.77	11.95
N_4 - 60Kg chemical N/fad.+ 60 kg N (Compost)	10.80	12.40	11.6
N_5-30Kg chemical N/fad.+ 90 kgN (Compost)	10.73	13.11	11.92
N_6-120 kgN (Compost)	10.47	12.73	11.6
N_7 – Cerealine + 90 Kg chemical N/fad. + 30 kgN Compost)	11.20	13.35	12.27
N_8 Cerealine + 60 Kg chemical N/fad.+60kgN (Compost).	10.95	13.17	12.06
N_9 - Cerealine + 30 Kg chemical N/fad.+90kgN(Compost).	10.54	12.53	11.54
N_{10} -Cerealine +120 kgN (Compost).	10.54	12.78	11.66
N_{11} -Cerealine	10.58	13.65	12.12
Average	10.87	13.08	11.98
F.test	NS	NS	NS
Phosphorus fertilization regimes(B)			
P_1-control	11.12	13.01	12.07
P_2 -45 kgP_2O_5/fad.	10.76	13.13	11.94
P_3 -30kg P_2O_5/fad.+Phosphorien (600g)	10.79	13.08	11.93
P_4 -15 kg P_2O_5/fad. +Phosphorien (1200g)	10.84	13.22	12.03
P_5 –Phosphorien (1800g)	10.84	12.97	11.90
Average	10.87	13.08	11.98
F. test	NS	NS	NS
AB	NS	NS	NS

Means followed by different letters are significantly different where * and ** indicate significant at 0.05 ,0.01 as well as NS indicate not significant.

Impact of nitrogen fertilization regimes

Results of both seasons and their combined analysis exhibited that various nitrogenic fertilization regimes which provided maize plants with 120kg N/fad., from different sources *i.e*. chemical fertilizer, compost and their combination in different portions with or without cerealine biofertilizer, were effectless on number of leaves/plant at 70 days after sowing (DAS). Respecting to combined analysis, number of leaves/plant ranged between 11.54 and 12.77. Otherwise, **Mahato and Neupane (2017)** ensured that the integrated fertilization regimes (*Azotobacter* seed coated + *Trichederma* soil inoculated + 10ton FYM/ha.+ 120 : 40 : 40 NPK kg/ha.) produced the highest number of leaves per maize plant, the increase valued 51.2% over the control.

Impact of phosphorus fertilization regimes

Phosphorus fertilization regimes applied in this study elucidated exiguous variation in leaf number/plant which were insignificant. The range of leaf number/plant was from 11.9 to 12.07 with an average of 11.98.

The interaction between nitrogen and phosphorus fertilization regimes was nidgin.

Number of Leaves under and Above the Ear

Results given in Table 3 testify the effect of both nitrogen and phosphorus fertilization regimes on number of leaves under and above the ear (70 DAS).

Impact of nitrogen fertilization regimes

The results compiled in Table 3 clearly show that number of leaves either under or above the ear of mono eared maize plant were not affected due to applying different nitrogen fertilization studied. Influence of nitrogen fertilization regimes on leaf number under and above maize ear was immutable in spite of the different sorts of fertilizers used in different regimes. Imparity of number of leaves under and above the ear was noticeable wherein number of leaves under ear was greater and valued 7.19 in average, while that number of leaves above ear was smaller and valued 4.50 in average (combined data). Results reported by **Coulibaly *et al.* (2019)** showed that vermicompost gave the highest number of leaves under the ear (7.95).

Impact of phosphorus fertilization regimes

The inoperative impact of phosphorus fertilization regimes on leaf number either under or above the ear was disclosed in both seasons and the combined analysis. The interaction effect of nitrogen and phosphorus fertilization regimes on number of leaves under and above the ear was abortive.

Leaf Area (cm^2/plant)

Leaf area (cm^2/plant) at 70DAS of maize plant as affected by nitrogen and phosphorus fertilization integrated regimes is presented in Table 4.

Impact of nitrogen fertilization regimes

Differences in maize leaf area/plant at 70DAS which resulted due to application of various nitrogen fertilization regimes, were irresponsible in the second season and the combined analysis. Otherwise, variations in leaf area/maize plant were significant in the first season only. The largest leaf/ plant was (4254.22cm^2/plant) obtained with the appliance of the integrated N fertilization regimes N_3 (90kg N from chemical fertilizer +30 kg N from compost) while the smallest leaf area/plant (2636.09 cm^2/plant) was the resultant of supplying plant with sole N- fixing biofertilizer" cerealine". The differences in maize leaf area/ plant among the nitrogen fertilization regimes N_2, N_3, N_4, N_5, N_7 and N_8 were immaterial. Availability of 120kg N/fad., regardless the N fertilizer sort aid in achievement of larger leaf area/plant, but from the environment view, alleviation of nitrogen from chemical fertilization regimes is an important goal, accordingly the integrated fertilization regimes N_8 (cerealine + 60kg N from chemical fertilizer + 60kg N from compost) which is at par with N_2 (sole chemical fertilizer, 120 kg N/fad.) concedared more pertinacity.

Gholami *et al.* (2009) alluded that maize leaf area/plant was increased significantly due to the bacterial inoculation. Also, **El-Shafey and El-Hawary(2016)** divulged that, the higher maize leaf area/plant were recorded due to the application of 60 and 90 kg chemical N/fad., combined with the biofertilizer "cerealine".

Impact of phosphorus fertilization regimes

Ineffective differences in maize leaf area / plant at 70DAS were noted in both seasons and their combined analysis. It means that maize leaf area/plant were at par under the various phosphorus fertilization regimes studied. Accordingly, using of the biofertilizer "phosphorien" which is eco- frindly and so cheap is a benign environment profile.

Results of both seasons as well as the combined analysis reflected the insignificant effect of nitrogen and phosphorus fertilization regimes interaction on leaf area of maize plant at 70DAS.

Area of Leaves under and Above the Ear (cm^2/plant)

Results concerning area of leaves under and above ear per plant at 70DAS, are displayed in Table 5.

Table 3. Effect of nitrogen and phosphorus fertilization regimes on number of leaves under and above the ear (70DAS) of maize plant in 2017 and 2018 seasons

Main effect and interaction	Number of leaves under the ear		Comb.	Number of leaves above the ear		Com.
	2017	2018		2017	2018	
Nitrogen fertilization regimes (A)						
N_1-Control	6.59	8.21	7.40	4.22	5.44	4.80
N_2-120Kg chemical N/fad.	7.15	8.52	7.80	4.73	5.21	5.00
N_3 -90Kg chemical N/fad.+ 30kgN (Compost)	6.63	7.61	7.12	4.47	5.15	4.80
N_{4-} 60Kg chemical N/fad.+ 60kgN (Compost)	6.18	7.35	6.77	4.65	5.04	4.80
N_5-30Kg chemical N/fad.+ 90kgN (Compost)	6.31	7.71	7.01	4.55	5.41	5.00
N_6-120kgN(Compost)	6.20	7.63	6.91	4.31	5.12	4.70
N_7-Cerealine+90Kg chemical N/fad. +30 kgN Compost)	6.80	8.26	7.53	4.49	5.09	4.80
N_8 Cerealine+60Kg chemical N/fad.+60kgN (Compost)	6.49	8.23	7.36	4.46	4.96	4.70
N_9-Cerealine+30Kg chemical N/fad.+90kgN (Compost)	6.24	7.53	6.80	4.42	5.00	4.70
N_{10} -Cerealine +120kgN (Compost)	6.27	7.77	7.02	4.24	5.03	4.60
N_{11} -Cerealine	6.23	8.25	7.24	4.31	5.39	4.80
Average	6.46	7.92	7.19	4.44	5.17	4.80
F.test	NS	NS	NS	NS	NS	NS
Phosphorus fertilization regimes(B)						
P_1 –control	6.70	7.76	7.23	4.53	5.26	4.90
P_2 -45 kgP_2O_5/fad.	6.36	7.94	7.15	4.42	5.18	4.80
P_3 -30kg P_2O_5/fad.+Phosphorien (600g).	6.40	7.90	7.15	4.43	5.16	4.79
P_4 -15 kg P_2O_5/fad +Phosphorien (1200 g).	6.44	8.04	7.24	4.40	5.18	4.79
P_5 –Phosphorien (1800g).	6.43	7.93	7.18	4.41	5.06	4.73
average	6.46	7.92	7.19	4.44	5.17	4.80
F. test	NS	NS	NS	NS	NS	NS
AB	NS	NS	NS	NS	NS	NS

Means followed by different letters are significantly different where * and ** indicate significant at 0.05 ,0.01 as well as NS indicate not significant.

Table 4. Effect of nitrogen and phosphorus fertilization regimes on leaf area (m^2/plant) (70DAS) of maize in 2017 and 2018 seasons

Main effects and interaction	Leaf area (cm^2/plant)		Comb.
	2017	2018	
Nitrogen fertilization regimes (A)			
N_1-Control	2807.76d	5580.55	4194.1
N_2-120Kg chemical N/fad.	4150.84ab	6283.27	5217.05
N_3 -90Kg chemical N/fad.+ 30 kgN (Compost)	4254.22a	5411.57	4832.90
$N_{4\ -}$ 60Kg chemical N/fad.+ 60 kgN (Compost)	4027.41ab	4929.67	4478.54
N_5-30Kg chemical N/fad.+ 90 kgN (Compost)	3651.26abc	5154.46	4402.86
N_6-120kgN (Compost)	3096.56cd	5706.66	4401.61
N_7 - Cerealine+90Kg chemical N/fad. +30kgN Compost)	3734.864abc	6438.04	5086.45
N_8 Cerealine+60Kg chemical N/fad.+60kgN (Compost)	4148.21ab	6600.57	5374.39
N_9 - Cerealine+30Kg chemical N/fad.+90kgN(Compost)	3417.55bcd	5346.31	4381.93
N_{10} -Cerealine +120kgN (Compost).	2966.94cd	5173.41	4070.17
N_{11} -Cerealine	2636.09d	5049.53	3842.81
Average	3535.61	5606.73	4571.17
F. test	**	NS	NS
Phosphorus fertilization regimes(B)			
P_1 –control	3645.31	5512.83	4579.07
P_2 -45 kgP_2O_5/ fad.	3507.05	5560.83	4533.94
P_3 -30kg P_2O_5/ fad.+Phosphorien (600g).	3490.58	5788.54	4639.56
P_4 -15 kg P_2O_5/ fad +Phosphorien (1200g).	3443.32	5489.95	4466.64
P_5 –Phosphorien(1800g).	3591.78	5681.51	4636.65
average	3535.61	5606.73	4571.17
F. test	NS	NS	NS
AB	NS	NS	NS

Means followed by different letters are significantly different where * and ** indicate significant at 0.05 ,0.01 as well as NS indicate not significant

Table 5. Effect of nitrogen and phosphorus fertilization regimes on area of leaves under and above the ear (cm^2) (70DAS) of maize in 2017 and 2018 seasons

Main effect and interaction	Area of leaves under the ear (cm^2)		Comb.	Area of leaves above the ear (cm^2)		Comb.
	2017	2018		2017	2018	
Nitrogen fertilization regimes(A)						
N_1-Control	1689.96c	3340.73abcd	2515.34b	1117.81d	2239.821	1678.82
N_2-120Kg chemical N/fad.	2535.78a	3893.65abc	3214.72a	1615.06ab	2389.621	2002.34
N_3 -90Kg chemical N/fad.+ 30kgN (Compost)	2556.34a	3232.21bcd	2894.27ab	1697.88ab	2179.364	1938.62
N_4 - 60Kg chemical N/fad.+ 60kgN (Compost)	2282.08ab	2921.61d	2601.84b	1745.33a	2008.061	1876.69
N_5-30Kg chemical N/fad.+ 90kgN (Compost)	2110.78ab	3018.35d	2564.57b	1540.47abc	2136.107	1838.29
N_6-120kgN (Compost)	1797.36c	3421.58abcd	2609.47b	1299.21ced	2285.088	1792.15
N_7 - Cerealine+90Kg chemical N/fad. +30kgN (Compost)	2252.83ab	3984.46ab	3118.65a	1482.05bce	2453.575	1967.81
N_8 Cerealine+60Kg chemical N/fad.+60kgN (Compost)	2469.66ab	4117.65a	3293.66a	1678.55ab	2482.927	2080.74
N_9 - Cerealine+30Kg chemical N/fad.+90kgN (Compost)	2013.01ab	3205.07bcd	2609.04b	1404.54bce	2141.242	1772.89
N_{10} -Cerealine +120 kgN (Compost)	1762.85c	3134.17cd	2448.51b	1204.08ed	2039.246	1621.66
N_{11} -Cerealine	1564.26c	3052.66d	2308.4b	1071.84d	1996.871	1534.36
Average	2094.08	3392.921	2743.50	1441.53	2213.811	1827.67
F.test	**	**	**	**	NS	NS
LSD	467.97	307.61	458.41	319.59	-	-
Phosphorus fertilization regimes(B)						
P_1 –control	2165.42	3274.60	2720.01	1479.89	2238.23	1859.06
P_2 -45 kgP_2O_5/ fad.	2062.12	3372.064	2717.09	1444.93	2188.77	1816.85
P_3 -30kg P_2O_5/ fad.+Phosphorien (600g)	2066.78	3506.023	2786.40	1423.81	2282.52	1853.16
P_4 -15 kg P_2O_5/ fad +Phosphorien (1200g)	2034.37	3339.928	2687.15	1408.96	2150.02	1779.49
P_5 –Phosphorien (1800g)	2141.73	3471.987	2806.86	1450.06	2209.52	1829.79
average	2094.08	3392.92	2743.50	1441.53	2213.81	1827.67
F.test	NS	NS	NS	NS	NS	NS
AB	NS	NS	NS	NS	NS	NS

Means followed by different letters are significantly different where * and ** indicate significant at 0.05 ,0.01 as well as NS indicate not significant.

Impact of nitrogen fertilization regimes

Nitrogen fertilization regimes markedly acted on area of leaves under the ear (cm^2/plant) in both seasons and the combined analysis, while the differences were significant in area of leaves above the ear in the first season. In general and from the combined analysis, it could be seen that average area of leaves under ear (2743.50 cm^2), was langer than average area of leaves above the ear (1827.67cm^2), about 60% of total leaf area (cm^2/plant) is under the ear.

Integration between inorganic N fertilizer and organic N fertilizer without biofertilizer (N_3) or with biofertilizer (N_7 and N_8) were at par with sole inorganic fertilizer (N_2) regarding area of leaves under ear (combined analysis). Area of leaves under ear resulted from the integrated fertilization regime (cerealine + 60 kg chemical N + 60 kg N from compost) was larger than that in the control treatment by 30.94% based on combined results. Regarding to the area of leaves above the ear, results of the 1st season displayed that area of leaves above the ear were at par in treatments N_2, N_3, N_4, N_5 and N_6.

Impact of phosphorus fertilization regimes

It's evident from the results shown in Table 5 that the impact of various phosphorus fertilization regimes on area of leaves under and above maize ear was ineffectual in both seasons and the combined analysis. It's of great moment to note that impact of chemical phosphorus and phosphorus biofertilizer were at par in their impact on area of leaves under and above the ear.

Both nitrogen and phosphorus fertilization regimes interaction has insignificant effect on area of leaves under or above the ear.

Leaf Area Index (LAX)

Results in Table 6 demonstrate the impact of nitrogen and phosphorus fertilization regimes on maize leaf area index at 70DAS.

Impact of nitrogen fertilization regimes

Significant differences in maize leaf area index at 70DAS, due to various nitrogenic fertilization regimes, were only recorded in the first season. Application of either 120kg chemical fertilizer (N_2) or 90kg chemical N + 30 kg N from compost was conjucated with larger values of leaf area index comparably with other regimes. In spite of the insignificant variation in LAI among fertilization regimes in the 2nd season and the combined analysis, LAI under nitrogen fertilization regimes N_2, N_3, N_7 and N_8 increased to some extent over other regimes.

El-Shafey and El-Hawary (2016) recorded that high values of LAI were obtained with appliance of 60 or 90kg chemical nitrogen plus organic fertilizers. As well, **El-Shahed (2017)** recorded significant increase in maize LAI when nitrogen level raised to 135kg chemical N/fad. More recent, **Reddy *et al.*(2018)** quoted that application of chemical N(300kg/ha.) produced larger LAI compared to application of 250 or 200 kg N /ha.

Impact of phosphorus fertilization regimes

Leaf area index ranged between 2.27 under P_4 treatment and 2.45 under P_2 regime. Differences in LAI values of maize plants due to various phosphorus fertilization regimes were of no effect. The same manner was observed in each of number of leaves/plant (Table 5) number of leaves under and above the ear (Table 3) and leaf area/plant (Table 4).

Impact of the interaction

Interaction effect between nitrogen and phosphorus fertilization regimes on maize LAI (70DAS) was significant in the combined analysis, and is presented in Table 6-a. The highest three values of LAI *viz* 3.32, 3.21 and 3.15 were the resultant of the three interaction viz control phosphorus× (cerealine + 90 kg chemical N/fad. + 30 kg N from compost), 45kg P_2O_5/fad.× (120kg N/fad. from compost) and {120 kg chemical N × Phosphorien (1800g)} in respective order. The lowest value of LAI (1.69) was obtained from the control interaction *i.e.* under both nitrogen and phosphorus deficiency.

Ear Leaf Area (cm^2)

Results in Table 7 display the influence of nitrogen and phosphorus fertilization regimes on ear leaf area (m^2) at70 DAS.

Impact of nitrogen fertilization regimes

Ear leaf area (cm^2) at 70 DAS, exhibited marked variation due to varying nitrogen fertilization regimes in first season and the pooled

Table 6. Effect of nitrogen and phosphorus fertilization regimes on leaf area index (LAI) (70DAS) maize in 2017 and 2018 seasons

Main effects and interaction	Leaf area index (LAI)		Comb.
	2017	2018	
Nitrogen fertilization regimes (A)			
N_1-Control	1.39f	2.74	2.07
N_2-120Kg chemical N/fad .	2.52ab	2.94	2.73
N_3 -90Kg chemical N/fad.+ 30kgN (Compost)	2.58a	2.40	2.62
N_4 - 60Kg chemical N/fad.+ 60kgN (Compost)	2.09bc	2.33	2.21
N_5-30Kg chemical N/fad.+ 90kgN (Compost)	1.95bcd	2.86	2.40
N_6-120kgN(Compost)	1.82cd	2.78	2.30
N_7 - Cerealine+90Kg chemical N/fad. +30kgN (Compost)	2.08bc	3.19	2.64
N_8 Cerealine+60Kg chemical N/fad.+60kgN (Compost)	1.91bcd	3.43	2.67
N_9 - Cerealine+30Kg chemical N/fad.+90kgN (Compost)	1.73cde	2.86	2.30
N_{10} -Cerealine +120kgN (Compost)	1.43def	2.89	2.16
N_{11} -Cerealine	1.26ef	2.30	1.78
Average	1.91	2.79	2.35
F. test	**	NS	NS
Phosphorus fertilization regimes (B)			
P_1- control	2.06	2.72	2.39
P_2- 45 kgP_2O_5/ fad.	1.96	2.93	2.45
P_3- 30kg P_2O_5/ fad.+Phosphorien (600g)	1.78	2.92	2.35
P_4- 15 kg P_2O_5/ fad. +Phosphorien (1200g)	1.85	2.69	2.27
P_5-Phosphorien (1800g)	1.91	2.70	2.30
average	1.91	2.79	2.35
F.test	NS	NS	NS
AB	NS	NS	**

Means followed by different letters are significantly different where * and ** indicate significant at 0.05 ,0.01 as well as NS indicate not significant.

Table 6-a. Interaction effect between nitrogen and phosphorus fertilization regimes on maize leaf area index(LAI) (70 DAS)

NFR / PFR	N_1-Control	N_2-120Kg chemical N/fad .	N_3 -90KgN/fad.+ 30kgN (Compost)	N_{4} - 60Kg chemical N/fad.+ 60kgN (Compost)	N_5-30Kg chemical N/fad.+ 90kgN (Compost)	N_6-120kgN(Compost)	N_7 - Cerealine+90Kg chemical N/fad. +30kgN Compost)	N_8 Cerealine+60Kg chemical N/fad.+60kgN (Compost).	N_9 - Cerealine+30Kg chemical N/fad.+90kgN (Compost).	N_{10} -Cerealine +120kgN (Compost).	N_{11} -Cerealine
P_1 control	BC 2.42 ab	BC 2.27 b	AB 2.69 ab	C 1.97 b	BC 2.43 ab	BC 2.24 bc	A 3.32 a	BC 2.26 b	BC 2.48 a	BC 2.40 a	C 1.84 ab
P_2 45 kg P_2O_5/fad.	AB 2.54 a	Ab 2.66 b	AB 2.79 ab	BC 2.32 ab	AB 2.58 ab	A 3.21 a	AB 2.63 b	AB 2.60 ab	CD 1.66 b	AB 2.47 a	D 1.47 b
P_3 30kg P_2O_5/fad. + Phosphorien (600g).	CDE 1.91 bc	AB 2.95 ab	ABCD 2.45 ab	DE 1.81 b	AB 2.62 a	ED 1.74 cd	ABC 2.51 b	A 3.00 a	AB 2.96 a	BCDE 2.20 ab	E 1.67 ab
P_4 15 kg P_2O_5/ fad + Phosphorien (1200g).	D 1.79 c	ABC 2.63 b	AB 2.88 a	ABC 2.67 a	CD 2.08 b	D 1.69 d	ABCD 2.40 b	A 2.90 ab	CD 1.92 b	D 1.85 b	BCD 2.15 a
P_5 Phosphorien (1800g).	D 1.69 c	A 3.15 a	BCD 2.27 b	BCD 2.26 ab	ABCD 2.32 ab	AB 2.62 b	ABCD 2.34 b	ABC 2.58 ab	AB 2.46 a	BCD 1.89 b	CB 1.78 ab

NFR= Nitrogen fertilization regimes. PFR=Phosphorus fertilization regimes.

Table 7. Effect of nitrogen and phosphorus fertilization regimes on ear leaf area (cm^2) 70 (DAS) of maize in 2017 and 2018 seasons

Main effects and interaction	Ear leaf area (cm^2)		Comb.
	2017	2018	
Nitrogen fertilization regimes(A)			
N_1-Control	394.26f	569.48	481.87e
N_2-120Kg chemical N/fad.	598.19ab	613.70	605.95ab
N_3 -90Kg chemical N/fad.+ 30kgN (Compost)	585.95ab	579.60	582.77abc
N_4 - 60Kg chemical N/fad.+ 60kgN (Compost)	540.79abc	511.52	526.15de
N_5-30Kg chemical N/fad.+ 90kgN (Compost)	508.29cd	541.50	524.9de
N_6-120kgN(Compost)	479.54cde	572.82	526.18cbe
N_7 - Cerealine+90Kg chemical N/fad. +30kgN (Compost)	601.37a	606.80	604.09ab
N_8 Cerealine+60Kg chemical N/fad.+60kgN (Compost)	584.1ab	667.68	625.89a
N_9 - Cerealine+30Kg chemical N/fad.+90kgN (Compost)	523.78bcd	597.75	560.77bcd
N_{10} -Cerealine +120kgN (Compost)	445.52def	553.42	499.47e
N_{11} -Cerealine	427.01ef	524.57	475.794e
Average	517.16	576.26	546.71
F.test	**	NS	**
Phosphorus fertilization regimes(B)			
P_1 –control	518.69	559.92	537.80
P_2 -45 kgP_2O_5/fad.	516.42	563.27	539.84
P_3 -30kg P_2O_5/fad. + Phosphorien (600 g)	501.17	582.98	542.08
P_4 -15 kg P_2O_5/fad. + Phosphorien (1200 g)	517.03	583.61	550.32
P_5 –Phosphorien (1800g)	532.51	594.52	563.51
Average	517.16	576.26	546.71
F. test	NS	NS	NS
AB	NS	NS	NS

Means followed by different letters are significantly different where * and ** indicate significant at 0.05 ,0.01 as well as NS indicate not significant.

Table 8. Effect of nitrogen and phosphorus fertilization regimes on tassel leaf area (cm^2) 70 (DAS) of maize in 2017 and 2018 seasons

Main effects and interaction	Tassel leaf area (cm^2)		Comb.
	2017	2018	
Nitrogen fertilization regimes(A)			
N_1-Control	119.55f	238.45	179.00cd
N_2-120Kg chemical N/fad .	196.90a	232.65	214.78abc
N_3 -90Kg chemical N/fad.+ 30kgN (Compost)	164.72bcd	239.28	202.00abc
N_4 - 60Kg chemical N/fad.+ 60kgN (Compost)	162.66bcd	221.68	192.17abc
N_5-30 Kg chemical N/fad.+ 90kgN (Compost)	149.74de	212.48	181.11cd
N_6-120 kgN (Compost)	147.95de	247.90	197.93abc
N_7 – Cerealine + 90Kg chemical N/fad. +30kgN (Compost)	184.42ab	267.97	226.19a
N_8 Cerealine+60Kg chemical N/fad.+60kgN (Compost)	178.21abc	257.52	217.87ab
N_9 - Cerealine+30Kg chemical N/fad.+90kgN (Compost)	155.79cde	213.35	184.57cd
N_{10} -Cerealine +120kgN (Compost).	134.09ef	196.30	165.20cd
N_{11} -Cerealine	131.01ef	170.97	150.99d
Average	156.82	227.141	191.98
F.test	**	NS	**
Phosphorus fertilization regimes(B)			
P_1 –control	156.81	216.82	186.82
P_2 -45 kgP_2O_5/fad.	158.49	231.02	194.75
P_3 -30kg P_2O_5/fad.+Phosphorien (600g)	158.35	235.69	197.02
P_4 -15 kg P_2O_5/fad. +Phosphorien (1200g)	151.67	214.24	182.96
P_5 –Phosphorien (1800g)	158.80	237.94	198.37
Average	156.82	227.142	191.98
F. test	NS	NS	NS
AB	NS	NS	NS

Means followed by different letters are significantly different where * and ** indicate significant at 0.05 ,0.01 as well as NS indicate not significant.

analysis of both seasons. According to combined analysis, ear leaf area ranged from 481.87m^2 in control treatment to 625.89 m^2 in the integrated nitrogen fertilization regime comprised cerealine + 60 kg chemical N/fad.,+60 kgN from compost.

Availability of 120 kgN/fad., from different sorts *i.e.* sole mineral N(N_2), combined mineral N+ organic N(compost) as in N_3 as well as combination of mineral N+ organic (compost)+ biofertilizer cerealine as in N_7 and N_8, was conjoined with larger ear leaf area. Comparison of ear leaf area under nitrogenic fertilization regimes N_2,N_3, N_7 and N_8 with N_1 (combined results) showed that they has increases valued 25.75, 20.94, 25.36 and 29.89% consecutively over the control. Analogous effective increase in each of leaf area (cm^2/plant) in the first season, area of leaves under and above the ear as well as leaf area index (Tables 4, 5 and 6), was achieved due to application of the same nitrogen fertilization regimes (N_2,N_3, N_7 and N_8).

Darwich (2013) and El-Sobky (2014) purported that ear leaf area in maize plants increased significantly due to mineral nitrogen fertilization up to 60 and 120kg N/fad., respectively. **El-Shahed (2017)** recorded an increase in maize ear leaf area due to application of 90kg N/fad., the promoter effect of integrated fertilization was detected by **El-Sobky and Desoky (2017)** wherein they obtained the largest ear leaf area due to the appliance of the integrated fertilization regimes, cerealine + phosphorien + 80% NP.

Impact of phosphorus fertilization regimes

Results of both seasons as well as their combined analysis reflected that all phosphorus fertilization regimes studied, failed to cuase significant inflacnce on maize ear leaf area (cm^2) at 70 DAS, Also, phosphorus fertilization regimes effect were immateriality respecting each of number of leaves/plant, number of leaves under and above the ear, leaf area/plant, area of leaves under and above the ear and leaf area index (Tables 2, 3 , 4, 5 and 6).

Contradicertily to our results, the favorable impact of mineral phosphorus on maize ear leaf area was reported by **Mukhtar *et al.* (2011), Khan *et al.* (2014) and Olusegun (2015).** Also, **El-Shahed (2017)** deposed that, application of 15.5 and 31.0kg P_2O_5/fad., increased ear leaf area by 11.03 and 17.39%, respectively.

Insignificant interaction between the two main factors under study on maize ear leaf area at 70DAS, was recorded in both seasons and the combined analysis.

Tassel Leaf Area (cm^2)

The effect of both nitrogenic and phosphorus fertilization regimes on tassel leaf area (cm^2) at 70DAS of maize plants is shown in Table 8.

Impact of nitrogen fertilization regimes

Result of first season and consolidated analysis revealed obvious variation in tassel leaf area (cm^2) at70 DAS due to the appliance of nitrogenous fertilization regimes. From the results of combined analysis, it could be noted that tassel leaf area ranged between 150.99 to 217.87 cm^2 under biofertilization (N_{11}) and the integrated fertilization regimes (N_8) in respective order.

Refering to the average values of ear leaf area and tassel leaf area superiorty of ear leaf area by more than two folds over tassel leaf area was recognizable in both seasons and their combined analysis. Availability of 120kg N/fad., from different fertilization regimes *i.e.* sole mineral nitrogen(N_2), and/or combination of chemical N+ organic N (compost)+ biofertilizer (ceralin) as in treatments N_7 and N_8 was conjoined with larger tassel leaf area in the first season and the combined analysis. Pertinent literature to that trait is very Poor.

Impact of phosphorus fertilization regimes

All phosphorus fertilization regimes under investigation were not efficient on maize tassel leaf area cm^2 at 70 DAS.

Insignificant interaction effect between nitrogen and phosphorus fertilization regimes on tassel leaf area was noted in both seasons and combined analysis.

REFERENCES

Amanullah, K.I., A. Jan, M.T. Jan, S.K. Khalil and Z. Shah (2015). Compost and nitrogen management influence productivity of spring maize (*Zea mays* L.) under deep and conventional tillage systems in Semi-arid regions. Commun. Soil Sci. Plant Anal., 46: 1566–1578.

Amanullah and A. Khan (2015) Phosphorus and compost management influence maize (*Zea mays*) productivity under semiarid condition withand without phosphate solubilizing bacteria. Front. Plant Sci. 6:1083. doi: 10.3389/ fpls.2015.01083.

Coulibaly, S.S., K.I. Kouassi, K.K. Koffi and B.I.A. Zoro (2019). Integrating vermicomposting in animal manure treatment to improve yield parameters of maize (*Zea mays*). Adv. Agric. Sci., 7 (2): 48-58.

Darwich (2013). Effect of N rates, compost and humic acid treatments on growth and yield components of maize Ph.D. Thesis, Fac. Agric., Mansoura Univ., Egypt.

Duncan, D.B. (1955). Multiple Range and Multiple F-Test. Biometrics, 11:1-42.

El-Shafey, A. and M.M. El-Hawary (2016). integrated effect of bio-organic and/or nitrogen fertilizer on growth and yield of maize (*Zea maize* L.). Zagazig J. Agric. Res., 43 (4):1105-1119.

El-Shahed, H.M.M. (2017). Physiological resporse of maize hybrids to nitrogen and phosphours fertilization, Ph.D. Thesis, Fac. Agric. Zagazig Univ., Egypt.

El-Sobky, E.E.A.M. (2014). Effect of some agronomic practices on productivity of maize. Ph.D. Thesis, Fac. Agric., Zagazig Univ., Egypt.

El-Sobky, E.E.A. and E.M. Desoky (2017). Influence of inrigation interval, Bio and mineral fertilization and their interaction on some physiological, anatomical features and productivity of maize. Zagazig J. Agric. Res. 44 (1): 23-40.

Fazlullah, M.A., F. Shah, S. Iqbal, M. Arshad, D. Muhammad, F. Wahid, A. Hussain, M. Roman, R. Perveez and M. Noor (2018). Integrated application of phosphorus (p) and phosphate solubilizing bacteria (psb) improve maize yield. Pureand Appl. Biol. (*PAB*) [Online], 7 (2): 494-499.

GAIN, R. (2018). Number:EG18020. Date: 9/9/2018. Jgjg jghttps://gain.fas.usda.gov/ Recent%20GAIN%20Publications/Grain%20 and%20Feed%20Update_ Caiiro_Egypt_9-9-2018.pdf

Gholami, A., S. Shahsavani and S. Nezarat (2009). The effect of plant growth promoting rhizobacteria (PGPR) on germination, seedling growth and yield of maize. WASET, 49: 19-24.

Kumar, D. and A.N. Jhariya (2013). Nutritional, Medicinal and Economical importance of Corn: AMini Rev. Res. J. Pharm. Sci., 2: 7-8.

Khattab, A.W.M., A.A.H. El-Khawaga, M.E. Saleh and I.E. Ramadan (2016). Some bio-chemical nitrogen and phosphorus fertilization regimes impacts on wheat (*Triticum aestivum* L.) productivity. Zagazig J. Agric. Res., 43 : 1.

Kamran, A., K. Ayub, N. Farah, I. Muhammad and A. Imran (2018). The impact of different p fertilizer sources on growth, yield and yield component of maize varieties. Agric. Res. Tech. Open Access J., 13 (3): 555881.

Khan, M.S., A. Zaidi and E. Ahmad (2014). Mechanism of phosphate solubilization and physiological functions of phosphate solubilizing microorganisms, In: Phosphate Solubilizing Microorganisms: Principles and application of microphos technology. J Springer Int. Publishing Switzerland, Switzer Land, 31: 62.

Khan, F., S. Khan, S. Hussain, S. Fahad and S. Faisal (2014). Different Strategies for Maintaining Carbon Sequestration in Crop Lands. Scientia Agric., 2: 62-76.

Mahato, S. and S. Neupane (2017). Comparative study of impact of Azotobacter and Trichoderma with other fertilizers on maize growth. J. Maize Res. and Dev., 3 (1): 1 -16.

Majid, M.A., I.M. Saiful, A. El-Sabagh, M.K. Hasan, M.O. Saddam, C. Barutcular, D. Ratnasekera, Kh.A.A. Abdelaal and M.S. Islam (2017). Influence of varying nitrogen levels on growth, yield and nitrogen use efficiency of hybrid maize (*Zea mays*). J. Exp. Biol. and Agric. Sci., 5 : 2.

Mckee, G.W. (1964). A coefficient for computing leaf area in hybrid corn. Agron. J., 56 : 240-241.

Mukhtar, T., M. Arif, S. Hussain, M. Tariq and K. Mehmood (2011). Effect of different rates of nitrogen and phosphorus fertilizers on growth and yield of maize. J. Agri. Res., 49: 333-339.

Olusegun, S.O. (2015). Nitrogen (N) and phosphorus (P) fertilizer application on maize (*Zea mays* L.) growth and yield at Ado- Ekiti, South-West, Nigeria. Am. J. Exp. Agric., 6 : 22-29.

Qureshi, M.A., Z.A. Ahmad, N. Akhtar, A. Iqbal, F. Mujeeb and M.A. Shakir (2012). Role of phosphate solubiliing bacteria (PSB) in enhancing p availability and promoting cotton growth. J. Anim. Plant Sci., 22 (1): 204-210.

Sharma, S.B., R.Z. Sayyed, M.H. Trivedi and T.A. Gobi (2013). Phosphate solubilizing microbes: Sustainable approach for managing phosphorus deficiency in agricultural soils. *SpringerPlus*, 2 : 587.

Snedecor, G.W. and G.W. Cochran (1967). 'Statistical Method 6th Ed. Iowa state Univ. Ame. Iowa. USA.

Reddy V.B., U.G.P. Reddy, M.S. Reddy and P. Kavitha (2018). Effect of Different Nitrogen and Phosphorus Levels on Growth and Yield of Maize during Kharif Season. Int. J. Curr. Microbiol. App. Sci., 7(1): 3548-3555.

Watson, D.J. (1952). The physiological basis of variation in yield. Adv. Agron., 4:101-140.

تأثير بعض النظم السميادية المتكاملة على بعض صفات نمو أوراق نبات الذرة

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أقيمت التجربة حقلية فى موسمي النمو الصيفين لعامين ٢٠١٧، ٢٠١٨ فى محطة التجارب الزراعية، كلية الزراعة، جامعة الزقازيق، مصر، استهدفت الدراسة معرفة تأثير أحدى عشر نظاما للتسميد النيتروجيني وخمسة نظم للتسميد الفوسفاتي على بعض صفات نمو الأوراق بنبات الذرة صنف هجين فردي ١٦٨عند عمر ٧٠ يوم من الزراعة وكانت أهم النتائج على النحو الآتي: لم يتأثر عدد الأوراق/النبات بإضافة ١٢٠كم ن/فدان من مختلف المصادر (سماد معدني- كمبوست- سماد حيوي) فى موسمي الزراعة وتحليل التباين المشترك، تم الحصول على أكبر مساحة لأوراق النبات ٤٢٥٤.٢٢ سم^{٢} نتيجة إضافة نظام التسميد النيتروجيني المتكامل (٩٠كم ن معدني/فدان + ٣٠كم ن من الكمبوست)، تفوقت مساحة الأوراق أسفل القوس عن مثيلتها هي معاملة الكنترول نتيجة إضافة النظام التسميدي المتكامل (سماد حيوي سيريالين + ٦٠كم ن معدني/فدان + ٦٠ كم ن من الكمبوست) بمعدل ٣٠.٩٤% كانت الفروق فى جميع صفات الأوراق تحت الورقة غير معنوي نتيجة تطبيق جميع نظم التسميد الفوسفاتي

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