SUMMARY

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Response of some high –yielding maize cultivars to mineral and Bio-Nitrogen fertilization

Two field experiments were conducted at Gemmiza Agricultural Research Station, Agrcultural Research Center, Tanta, Gharbya Governorate with maize (***Zea mays*** **L.**) cv. Single Way Cross 10 (SWC 10) and Three Way Cross 322 (TWC 322) during two consecutive summer seasons of year 1999 and 2000 to study the response of maize plants of these cultivars to mineral N fertilization at the rates of 80, 100, 120 or 140 kg N fed^{-1} with or without seed inoculation with biofertilizers viz. Cerealin, Rhizobacterin or uninoculated. It is also to study the combined effect of mineral and bio-nitrogen fertilization on soil microbial activity as measured via dehydrogenase activity (DHA) at the depth of 0 to 5 cm and 15 to 30 cm and rhizosphere soil content of NH^{+}_{4} and NO^{-}_{3}. The obtained results are summarized as follows:

A-<u>Effect of experimental treatments on N, P and K uptake by maize plants at 50 and 70 days after sowing (DAS)</u>:

1- Maize plants TWC 322 were significantly superior to their counterparts SWC 10 in the uptake of N, P and K at 50 DAS and N and P at 70 DAS, whereas the uptake of K at 70 DAS by both cultivars was insignificant.

2- Increasing N-level from 80 to 100 kg N fed^{-1} was accompanied by significant increase in N-uptake by maize cultivars at 50 and 70 DAS.

3- Maize cultivars at 50 and 70 DAS were significantly affected by seed inoculation with Cerealin biofertilizer of ***Azospirillum brasilense*** and Rhizobacterin biofertilizer of ***Azospirillum lipoferum*** **and** ***Azotobacter chroococcum*** mix. The two-biofertilizer treatments were significantly better than those uninoculated treatments concerning N-uptake at 50 and 70 DAS. However, Rhizobacterin significantly surpassed Cerealin in this respect at 70 DAS.

4- N and P-uptake at 50 DAS and N-uptake at 70 DAS significantly reached the highest value when N-fertilizer was applied at the level of 140 kg N fed^{-1} to SWC 10 plants, while K-uptake at 50 DAS significantly recorded its highest value when 80 kg N fed^{-1} was added to SWC 10 plants. P and K-uptake at 70 DAS were significantly max when N-levels of 100 and 120 kg N fed^{-1} were applied to SWC 10 plants, respectively. Conversely, N, P and K-uptake at 50 DAS and N-uptake at 70 DAS were significantly highest when 100 kg N fed^{-1} was used with TWC 322 plants. P and K-uptake by maize plants at 70 DAS significantly achieved the highest level when 120 kg N fed^{-1} was supplied to TWC 322 plants.

5- N-uptake by maize plants at 50 DAS significantly recorded its highest value when seeds of SWC10 cultivar were inoculated with Cerealin. Whereas, P and K-uptake at 50 DAS achieved maximum values when seeds of the same cultivar were not inoculated with either biofertilizer. Results also show that N-uptake by maize plants at 70 DAS significantly reached its best value when seeds of SWC 10

were inoculated with Rhizobacterin. While, P-uptake was slightly higher when maize seeds of the same cultivar were not inoculated with any of the biofertilizers without significant difference from those inoculated with Rhizobacterin. However, this high value was significantly higher than those inoculated with Cerealin. N and P-uptake by maize plants of TWC 322 at 50 DAS was significantly affected by seed inoculation with Rhizobacterin, while K-uptake by the same cultivar recorded its best value when seeds were not inoculated with either biofertilizer. N-uptake at 70 DAS was significantly affected by inoculation of seeds of TWC 322 cultivar with both biofertilizers, whereas P-uptake was not affected by inoculation of seeds of TWC322 cultivar with both biofertilizers. Results revealed also that K-uptake by maize plants of both cultivars at 70 DAS was not affected by inoculation of seeds with both biofertilizers.

6- Results pointed out that N-uptake by maize plants at 50 DAS was significant at the maximum level when Cerealin inoculated seeds were supplied with 80 kg N fed^{-1}, whereas P and K-uptake by maize plants at 50 and 70 DAS was not affected by seed inoculation with both biofertilizers. N-uptake at 70 DAS recorded the highest value when Rhizobacterin inoculated seeds were supplied with 100 kg N fed^{-1}. It could be concluded that the lower amount of mineral N fertilizer applied to maize plants the better nutrients uptake occurred.

B-Effect of experimental treatments on N, P and K concentration in ear leaf at 50% silking:

1- Results showed that maize plants of TWC 322 had significantly more N concentration than that in SWC 10, while P and K concentration had insignificant difference in both cultivars.

2- Results emphasized that increasing N-level from 80 to 100 kg N fed^{-1} increased significantly N concentration in ear leaf at 50% silking.

3- Data illustrated that when seeds of both cultivars were inoculated with Cerealin or Rhizobacterin, microbial strains in these biofertilizers caused significant effect on N concentration in ear leaf over those not inoculated with biofertilizer. It is also noticed from the results that biofertilizers had no significant effect on P and K concentration in ear leaf, as they are not P and K professionals.

4- Data revealed that N, P and K concentration in ear leaf at 50% silking in both SWC 10 and TWC 322 were not significantly affected by maize cultivars x N-levels interaction.

5- Data illustrated that TWC 322 x Rhizobacterin interaction had significant effect on N concentration in ear leaf at 50% silking, whereas SWC 10 x Cerealin or Rhizobacterin interaction had insignificant effect on N, P and K concentration in ear leaf.

6- Results clarified that interaction between 100 kg N fed^{-1} and Cerealin or Rhizobacterin had significantly best effect

on N concentration in ear leaf. However, this interaction had insignificant effect on P and K concentration in ear leaf at 50% sliking. This interaction showed that N_2 fixing bacterial strains existing in Cerealin and Rhizobacterin significantly effective in rhizosphere with low to medium level of N fertilizer concerning N concentration in ear leaf.

7- Maize cultivar SWC 10 x 100 kg N fed^{-1} x Cerealin had significant effect on N concentration in ear leaf at 50% silking, whereas maize cultivar TWC322 x 100 kg N fed^{-1} x Cerealin or Rhizobacterin interaction had a significant effect on N concentration in ear leaf at 50% silking. However, Cerealin in this interaction had more significant effect than Rhizobacterin. This triple interaction had insignificant effect on P and K concentration in ear leaf at 50% silking.

C- <u>Effect of experimental treatments on grain yield and its components:</u>

1- Maize cultivar SWC. 10 significantly surpassed its counterpart TWC 322 in respect of grain yield, grain weight ear^{-1} and weight of 100-kernels with the exception of straw yield, which recorded no significant difference between both cultivars under investigation.

2- Increasing N-levels from 80 to 100 kg fed^{-1} caused significant increase in grain yield and its components. However, higher doses of N application recorded no significant effect on grain yield and other relevant components.

3- Maize seeds inoculated with Cerealin or Rhizobacterin had significant effect on grain yield and all relevant components.

4- Excluding grain weight ear^{-1}, grain yield, 100-kernel weight and straw yield of the two cultivars under investigation were significantly affected by maize cultivars and N level interaction when N fertilizer was applied at the rate of 100 kg N fed^{-1}.

5- Maize grain yield, grain weight ear^{-1} and weight of 100-kernels were significantly affected by either Cerealin or Rhizobacterin in the presence of N fertilizer at the rate of 100 kg N fed^{-1}, while this interaction insignificantly affected straw yield fed^{-1} except with 120 kg N fed^{-1} and seed inoculation with Cerealin. Rhizobacterin in this interaction was significantly more favorable than Cerealin concerning grain weight ear^{-1} and weight of 100 kernels. However, the interaction of 80 kg N fed^{-1} with Cerealin had significant effect on grain weight ear^{-1}.

6- Inoculation of seeds of SWC 10 with either Cerealin or Rhizobacterin with application of 100 kg N fed^{-1} had significant effect on grain yield and grain weight ear^{-1}. Whereas, seeds of the same cultivar inoculated with Rhizobacterin and given 100 kg N fed^{-1} caused significant effect on weight of 100-kernels. Under these conditions, Cerealin had insignificant effect on this component. Meanwhile, straw yield of SWC10 was significantly affected when seeds of this cultivar were inoculated with either biofertilizer and given 120 kg N fed^{-1}. Inoculation of seeds of TWC 322 with either biofertilizer under

application of 100 kg N fed^{-1} brought about significant effect on grain yield, grain weight ear^{-1} and 100-kernel weight. Rhizobacterin in this interaction was significantly more effective than Cerealin. On the other hand, Cerealin other than Rhizobacterin inoculated seeds of TWC 322 under application of 100 kg N fed^{-1} caused significant effect on straw yield and also Cerealin inoculated seeds of SWC 10 and TWC 322 and supplied with 80 kg N^{-1} had significantly favorable effect on grain weight ear^{-1}.

D- **Effect of experimental treatments on grain content of N, P and K:**

1- Grains of both cultivars under investigation had no significant difference in their content of nutrient elements.

2- Raising N-level from 80 to 100 kg N fed^{-1} increased N content in grains. Conversely, increasing N-level successively from 100, 120 or 140 kg N fed^{-1} did not cause any significant effect on N content in maize grains. Concerning P and K content in grains, N treatments caused insignificant effect.

3- Cerealin or Rhizobacterin inoculation had significant effect on grain content of N. However, Cerealin was significantly more effective than Rhizobacterin on grain content of N. Regarding grain content of P and K, the results highlight that neither Cerealin nor Rhizobacterin had significant effect.

4- Interaction of either SWC 10 or TWC 322 with N-level of 100 kg N fed^{-1} was significantly effective on N content in grain. N content in grains of SWC 10 significantly

surpassed that of TWC322. Meanwhile, this interaction insignificantly affected P and K content in grains of both cultivars.

5- Inoculation of seeds of maize cultivar SWC 10 with Cerealin caused significant effect on N content in grains of this cultivar. Whereas, seed inoculation with Rhizobacterin insignificantly affected this content. In the contrary, inoculation of seeds of TWC 322 with either Cerealin or Rhizobacterin caused significant effect on N content in grains of this cultivar. Herein, Cerealin was more effective than Rhizobacterin. Concerning P and K content in grains of both cultivars, seed inoculation with either Cerealin or Rhizobacterin had insignificant effect.

6- Seed inoculation with either Cerealin or Rhizobacterin significantly interacted with N fertilizer to the greatest extent when N fertilizer was applied at 100 kg N fed^{-1}. Cerealin was significantly more effective on N content in grains. Meanwhile, the interaction of N-levels with either biofertilizer had insignificant effect on P and K content in grains.

7- Inoculation of seeds of SWC 10 with either Cerealin or Rhizobacterin in the presence of 100 kg N fed^{-1} significantly recorded the highest values of N content in grain. It is noticed that the two biofertilizers were statistically similar in their effect on N content in grains. On the other hand, inoculation of seeds of TWC 322 with Cerealin or Rhizobacterin in the presence of 100 kg N fed^{-1} recorded significant effect on N content in grains but

Cerealin was significantly more effective in this respect. This triple interaction was insignificantly effective on P and K content in grains.

E- <u>Effect of experimental treatments on soil rhizosphere concentration of NH_4 and NO_3:</u>

1- Maize cultivars had insignificant effect on soil concentration of NH_4 and NO_3 at all different times and depths of soil sampling.

2- Increasing N-level from 80 to 100 kg N fed^{-1} significantly increased soil concentration (ppm) of NH_4 after 50 and 70 DAS and soil concentration of NO_3 after 50, 70, 120 DAS at the depth of 0 to 15 cm. While raising N-level from 80 to 120 kg N fed^{-1} significantly enriched soil NH_4 after 120 DAS at the same depth. At depth of 15 to 30 cm the same grade of N fertilizer (i.e. 100 kg N fed^{-1}) significantly improved soil concentration of NH_4 after 50, 70, 120 DAS and NO_3 after 50, 70 DAS. However, this grade insignificantly affected NO_3 concentration after 120 DAS.

3- Both biofertilizers played an important role in enhancing soil fertility by improving soil concentration of NH_4 and NO_3 significantly after 50 and 70 DAS at the depth of 0 to 15 cm and 15 to 30 cm. Both biofertilizers were statistically indifferent and their effect on the two soil parameters was insignificant at 120 DAS and at both depths.

4- SWC 10 with N-level of 120 kg N fed^{-1} significantly improved soil concentration of NO_3 at the depth of 0 to 15cm and at 50 and 120 DAS. Whereas, TWC 322 with N-

level of 100 kg N fed^{-1} significantly improved soil concentration of NO_3 at the same depth and at 50 and 120 DAS. Both maize cultivars with all N-levels had insignificant effect on NO_3 concentration at the depth of 0 to 15 cm at 70 DAS. At 15 to 30 cm both cultivars with all N-levels had insignificant effect on soil concentration of NO_3 at all times of soil sampling.

5- The interaction emerged from both cultivars with either biofertilizer had insignificant effect on soil concentration of NH_4 at the depth of 0 to 15 cm and 15 to 30 cm at all times of soil sampling. In addition, the results revealed that both cultivars with either biofertilizer had insignificant effect on soil concentration of NO_3 at the depth of 0 to 15 cm at 50 and 70 DAS. Whereas both cultivars with both Cerealin and Rhizobacterin enriched soil concentration of NO_3 at the depth of 0 to 15 cm at 70 DAS. However, the interaction of SWC 10 with Rhizobacterin was significantly more effective on soil concentration of NO_3 than with Cerealin, and TWC 322 with Cerealin was significantly more effective on soil concentration of NO_3 than with Rhizobacterin at the depth of 0 to 15 and at 70 DAS. On contrast, both cultivars with either Cerealin or Rhizobacterin at the depth of 0 to 15 cm and at 120 DAS and at the depth of 15 to 30 cm and at all times of soil sampling had insignificant effect on soil concentration of NO_3 and NH_4.

6- The results indicated that N-level of 100 kg N fed^{-1} with Rhizobacterin was significantly more effective than

Cerealin on soil concentration of NH_4 at the depth of 0 to 15 cm and at 50 DAS. In this connection, N-level of 100 kg N fed^{-1} with either Cerealin or Rhizobacterin was significantly effective on soil concentration of NH_4 and NO_3 at the depth of 0 to 15 cm and at 70 DAS. However, all N-levels with either biofertilizer had insignificant effect on soil concentration of NH_4 at the depth of 0 to 15 cm and at 120 DAS. Concerning soil concentration of NO_3 at the depth of 0 to 15 cm and at 50 DAS, the results clarified that N-level of 80 kg N fed^{-1} with either Cerealin or Rhizobacterin significantly improved soil concentration of NO_3. Whereas, N-level of 120 kg N fed^{-1} with Rhizobacterin significantly enriched soil concentration of NO_3 at 120 DAS. On the other hand, this interaction was insignificantly effective on soil concentration of NO_3 at the depth of 15 to 30 cm and at 50 and 120 DAS. However, at 70 DAS, N-level of 80 kg N fed^{-1} with either Cerealin or Rhizobacterin improved soil concentration of NO_3.

7- Maize cultivar SWC 10 with N-level of 100 kg N fed^{-1} and either Cerealin and Rhizobacterin significantly enriched soil concentration of NH_4 at the depth of 0 to 15 and at 50 DAS whereas at 70 and 120 DAS this triple interaction was insignificantly effective. Moreover, this interaction was also insignificantly effective on soil concentration of NH_4 at the depth of 15 to 30 cm and at all times of soil sampling. As concern soil concentration of NO_3 at the depth of 0 to 15 cm, the results indicate that SWC 10 with 100 kg N fed^{-1} and Rhizobacterin significantly raised soil

concentration of NO_3 at 50 DAS whereas the same cultivar and N-level with either Cerealin or Rhizobacterin raised soil concentration of NO_3 at 70 DAS but at 120 DAS, this interaction was significantly ineffective. At the depth of 15 to 30 cm and at 50 and 70 DAS, this interaction was significantly ineffective on soil concentration of NO_3. However, TWC 322 with N-level of 140 kg N fed^{-1} and Rhizobacterin was significantly effective at 120 DAS. In conclusion the last finding emphasized that the experimental treatments currently used in this investigation increased soil content of NO_3 at harvest and as a consequence, soil fertility improved.

F- <u>Effect of experimental treatments on soil microbial activity as measured by dehydrogenase activity:</u>

1- Both cultivars under investigation had insignificant effect on soil DHA at the depth of 0 to 15 cm and 15 to 30 cm of the soil rhizosphere.

2- Increasing N fertilizer from 80 to 100 kg N fed^{-1} significantly increased microbial activity represented by DHA at both depths 0 to 15 cm and 15 to 30 cm of the soil rhizosphere and at soil sampling times of 50 and 70 DAS. However, the effect of N-levels had insignificant effect on microbial activity via DHA at both depths and at 120 DAS.

3- Both biofertilizers were significantly effective on dehydrogenase activity in soil rhizosphere at 50 and 70 DAS. However, both biofertilizers were significantly indifferent at 50 DAS at depths of 0 to 15 cm and 15 to 30 cm. At 0 to 15 cm and 70 DAS Rhizobacterin was

significantly more effective than Cerealin but at 15 to 30 cm Cerealin was insignificantly effective on DHA in soil rhizosphere.

4- The interaction of SWC 10 with Rhizobacterin significantly recorded better effect on DHA at 50 and 70 DAS. However, TWC 322 with Cerealin significantly recorded better effect at 50 DAS, Rhizobacterin was better at 70 DAS. At the depth of 15 to 30 cm both cultivars with Cerealin recorded better effect on DHA at 50 DAS and at 70 DAS Rhizobacterin was better with both cultivars. In addition, this interaction was significantly ineffective on DHA at the depth of 0 to 15 cm and 15 to 30 cm and at 120 DAS.

5- Maize seed inoculated with Rhizobacterin and received 100 kg N fed^{-1} recorded the highest significant effect on DHA in both outlined depths of soil rhizosphere at 50 and 70 DAS. However, the abovementioned interaction had insignificant effect on DHA at 120 DAS in both depths.

6- At the depth of 0 to 15 cm maize seeds inoculated with Rhizobacterin and supplied with 100 kg N fed^{-1} at 50 and 70 DAS recorded the highest significant value. Whereas this interaction recorded the highest value when maize seeds inoculated with either Cerealin or Rhizobacterin and given 140 kg N fed^{-1}. In the meantime, the triple interaction is significantly ineffective on DHA at 120 DAS and at all times of soil sampling at the depth of 15 to 30 cm.