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SUMMARY AND CONCLUSIONS

Part – I: Experiments conducted on sandy calcareous soil

The experiments conducted in this part aimed to increase the productivity of the calcareous sandy soil at Arab El-Awammer Research station Assiut-governorate. The poor productivity of the calcareous soils in this area are mainly due to low organic matter content, high $CaCO_3$ content (35%), low contents of nutrients and rapid fixation in unavailable form, and poor physical characteristics of soil reflected in rapid water percolation and crusting of soil surface. Therefore, the following approaches were tried for improving growth and yield of some common field crops grown in this area: (a) the application of different types of organic matters as amendments as well as resources of essential plant nutrients, (b) application of elemental S, at different rates, as acidifying agent for lowering soil pH and increasing availability of fixed nutrients, particularly phosphorus, (c) trying some biofertilizers and microbial inoculations as means to increase availability and partially supply the N and P requirements of the inoculated plants.

Two pot experiment on wheat, and several field expts. were conducted on wheat, peanut and sunflower that were grown on the sandy calcareous soil of Arab El-Awammer Experimental station.

The obtained results could be summarized in the following:

Pot experiments on wheat (2004/2005)

1. Significant improvement of wheat growth and yield in pots, by grain inoculation treatment with; yeast (Y) – phosphorein (P) – *Thiobacillus* bacteria (T) – mixture of Y + P + T compared to the uninoculated control. The highest increments were recorded by yeast inoculation (single or in mixture).

2. S-application in powdered form at rate of 600 kg/fa significantly improved plant growth (dry wt.) and induced significant or highly

significant increases in yield (total, straw, and grains) as well as grain uptake of N and P.

Field experiments on wheat

The three field experiments; two conducted in season of 2005 and the third in season 2006, tested; response of wheat to: different levels of mineral nitrogen fertilization; application of different types of organic matter; and different rates of powdered S-application:

In the First Expt.

1. Increasing the N-fertilization rate from 120 to 150 kg/fa significantly improved plant growth and uptake of N and P and resulted in significant increases in yield (straw, grain and total) and yield components (No. of spikes/m^2 and wt. of 1000 grains).

2. S-application at the levels 400 and 600 kg powdered S/fa caused significant or highly significant increases in plant growth and N and P uptakes as well as in yield and yield components compared with the control (zero S) or the treatment supplied with 200 kg S/fa. The highest values of all tested parameters were obtained from the application of 600 kg S/fa, but non significantly different from those of the 400 kg S treatment.

The application of 400 kg S and 600 kg S/fa respectively resulted in increases of 11.5% and 17.8% in grain yield; whereas the respective increased values in straw yield were 12.5% and 21%.

3. S-application treatments resulted in significant reduction in soil pH, showing highest reducation in the treatment given 600 kg/fa and recording the lowest values after 30 days and 60 days from sowing then increased afterwards, but at harvest continued to be lower than the untreated control.

4. The EC of soil suspension showed sharp increases with S-application levels, and reached maximum after 60 days from sowing, but showed declined values at harvest.

5. The reductions in soil pH induced by the S-application levels were associated with the increases in soil available P determined at harvest and with the increases in EC of soil suspension.

The second field expt.

Tested, in split plot design expt., response of wheat to S-application (Zero- 600kg/fa) and to five organic matter treatments: without O.M. – Farmyard manure (FYM) Chicken manure (CM) – Vinasse (V) and Town wastes (TW) in addition to 120 kg/fa mineral nitrogen.

The obtained results were:

1. With the exception of vinasse, wheat vegetative growth, and uptakes of N and P were significantly or highly significantly improved by the application of organic matter. (FYM, CM, TW at rate of 100 kg N/fa). The highest improvements were recorded in the (TW) treatment.

Also, the (TW)-application treatment, produced the highest yields (straw, grain, total) and yield components of all organic matter treatments followed by (FYM) and (CM) without significant differences among them.

2. The application of vinasse (5 ton/fa) induced the lowest increases in wheat yields (total, straw, grain) and N and P uptakes, but those produced were still significantly or highly significantly higher than those of the untreated control.

3. The increases in grain yield were 39.0, 36.1, 32.0 and 14.3 %, respectively by application of (TW), (CM), (FYM) and (V), while the increases in straw yield were 62.3, 44.9, 52.9 and 27.9 %, respectively with (TW), (CM), (FYM) and (V).

4. S-application, at the rate of 600 kg/fa, induced significant improvements in all growth parameters and nutrient uptakes of wheat during the vegetative stage, and was reflected in significantly higher yields (grain, straw, and total) and total N and P uptakes at harvest.

5. S-application induced significant reducation in soil pH and resulted in significant increase in soil available P at harvest. After 30 and 60 days from sowing the lowest recorded soil pH_{es} were in (TW) and (FYM) treatments, and at harvest, the soil pH of the (TW) treatment was still the lowest recorded of all organic matter types, registering 0.32 pH unit lower than the untreated control.

6. There were significant positive interactions between S-application (600 kg/fa) and each of (TW) or (FYM) treatments reflected in significant increases in grain yield and no. of spikes/m^2 as well as P uptake in grains. The increases in grain yield due to S-application with (TW) and (FYM), respectively were 21.9% and 29.0%, and in straw yields 11.1% and 13.3%.

The third field expt.

Tested, in split plot experimental design, response of wheat to S-application at rate of 300 kg/fa and to different levels of mineral N-fertilization: 60 – 90 - 120 - 150 kg N/fa [in addition to organic nitrogen (TW) added to all plots at rate of 100 kg/fa].

The obtained results were:

1. Additive increases in plant growth (fresh and dry wts.), N and P uptakes by plants, as well as in yield and yield components resulted from increasing N-fertilization from 60 to 150 kg/fa. The increases were significant or highly significant by application of 90 kg N/fa compared with the treatment given 60 kg N/fa. Above that level the recorded increases were non-significant compared with those of the 90 kg N/fa treatment, and are less beneficial to the farmer compared with costs of

the excess amounts of N-fertilizer added (extra 30 or 60 kg N/fa). Therefore, we consider that the 90 kg N/fa is the recommended economic level of mineral N for wheat production in the calcareous soil of Arab El-Awammer, particularly when organic matter is applied to soil as amendment and nutrient supply.

2. The results of this field experiment of (2006), show that S-application at 300 kg/fa to wheat induced highly significant improvements in plant growth and N and P uptakes and resulted in highly significant increases in yield and yield components. The increases in this expt. in grain, straw and total yield, respectively were 231, 222 and 453 kg/fa by S-application at rate of 300 kg/fa, compared with the respective values: 201, 189 and 390 kg/fa obtained by 600 kg S/fa in the field experiment of 2005. Therefore, we consider that 300 kg S/fa is the economic level of S-application to soil at Arab El-Awammer calcareous soil.

3. S-application at rate of 300 kg/fa significantly interacted with levels of mineral N-fertilization, especially the low levels (60 and 90 kg N/fa), and this was reflected in significant increases in grain yield and total N-uptake. The calculated excess increase in grain yield in the treatment 90 kg N/fa + 300 kg S/fa was 16.7%, and in the treatment 150kg N+300 kg S/fa was 18.9%.

Field experiments on peanut

Two field experiments were conducted on peanut (*Arachis hypogae* L. cv. Giza 6) grown on the sandy calcareous soil of Arab El-Awammer.

The first experiment, conducted on summer season of (2005), was executed on the same location of second wheat experiment and on same layout of tested treatments: organic manures (FYM, CM, TW, V and control) were in main plots and S-application (Zero- 600/fa) in sub plots. The recorded responses obtained in this expt. are due to newly applied additives as well as to the residual organic additives from wheat experiment. The second field

experiment conducted on summer season of 2006, was exactly a repetition of the first peanut expt. of (2005) except that, chicken manure was excluded, the tested S-levels were (Zero - 300kg fa) and the experiment was executed on non-cultivated new field at Arab El-Awammer Station.

The obtained results from the two experiments are summarized in the following:

1. The application of any type of organic matter (FYM, CM, TW or V) induced highly significant increases in plant growth parameters (fresh and dry weights, N concentration) and N uptake and resulted in highly significant increases in yields of pods, straw, total and seeds. But the most beneficial were (V) and (TW), indicated from the highest pod and seed yields that were obtained in the vinasse and (TW) treatments with no significant differences between them. The (FYM) treatment produced the highest total yield.

2. In the first experiment, the increases in pod yield by (V) and (TW) application were 27.4 and 32.4% respectively, and in seed yield 42.8 % and 40.0%, respectively. And in the second experiment, the % increases in pod yield by (TW), (V) and (FYM) application, respectively were 32.2%, 23.1% and 22.2%; and the corresponding values for seed yield were 35.5%, 30.8% and 22.0%, respectively.

3. S-application to peanut (at rate of 600 kg/fa in season 2005, or at rate of 300 kg/fa in season 2006) caused highly significant improvements in plant weights (fresh and dry), N and P uptakes by plants and resulted in highly significant increases in pod, seed, straw and total yields, as well as % P in seeds. The percentage increases in pod yield and seed yield by S-application, respectively were 17.0% and 19.5% in season 2005 and were 11.6% and 13.1% in season of 2006. The significant increases in plant growth and peanut yield scored by S-application in both season

are attributed to the reducation in soil pH and to the increases in available P.

4. The synergetic effect of applied S with organic matter types on peanut yield obtained was quite obvious in both seasons.

Field experiments on sunflower

The two field experiments conducted on summer season of 2005 & 2006 tested response of sunflower to inoculation with ((Phosphorein)) and to N-fertilization treatments. In both experiments, the N-fertilization treatments: (60 kg mineral N/fa – 60 kg organic N/fa – 30 kg mineral N/fa + 30 kg organic N/fa - 60 kg mineral N/fa + 30 kg organic N/fa) were laid in the main plots, while uninoculation or inoculation with ((Phosphorein)) were laid in the sub plots with four replications.

The statistical combined analysis of results of the two seasons are summarized in the following:

1. The best response was obtained when half of the given N-amount was in mineral-form and the other half in organic-form; and the lowest response was obtained when all added-N was in organic-form.

2. The treatment given 30 kg mineral N+30 kg organic N/fa came in the first rank, inducing the highest vegetative growth, N and P uptakes and scoring the highest seed, straw and total yield, as well as highest oil yield (307 kg/fa). This treatment scored 18.9% increase in seed yield and 18.8% increase in oil yield compared with the treatment given 60 kg/fa mineral N.

3. Phosphorein application was highly significant in promoting plant growth (root and shoot wts., no. of leaves/plant, and N&P uptakes) and in increasing yield and yield components. The increases in faddan seed yield and oil yield by phosphorein inoculation respectively were 10.6% and 11.1%. These recorded increases, are attributed to the increase in amounts of available P by the phosphate-solubilizing bacteria in the

applied biofertilizer as indicated from the data of soil available P at harvest of sunflower.

Part - I I: Experiments conducted on clayey soil of Fact. Agric. Assiut Univ.

This part included two field experiments that were conducted on the clayey soil at the Experimental Farm of Faculty of agricultural, Assiut University to ascertain the value of yeast inoculation on onion and maize yields, and to evaluate the direct effects of S-application on onion and residual S-effect on succeeding maize.

The first experiment on onion, conducted during the winter season of 2004/2005, tested the effect of S-application (zero and 600 kg/fa) and seedling inoculation with suspension of activated yeast (*Saccharomyces cereveciae*) on growth and yield of onion (*Allium cepa* L., cv. Giza-6). The experimental design was a split plot design with three replications.

Results:

1. S-application significantly increased dry shoot weight, N concentration (%) in plants, and N and P uptakes and resulted in significant increases in total and bulb yields and dry matter % in bulbs. The % increases in total and onion bulb yields, due to S-application, respectively were 16.5% and 19.1% and the increase in bulb dry-matter was 16.2%. In comparison, the calculated increases in total and bulb yields due to yeast inoculation were 8.5 and 9.6%, respectively and the increases in bulb dry matter was 7.1%.

2. These obtained results indicate that S-application to soil at the tested level (600 kg/fa), was more promotive to onion growth and produced higher increases in bulb yield and quality (% dry matter) compared to yeast inoculation. Economically, the cost of S-application might be more expensive than yeast inoculation, yet the positive effect of residual S on the succeeding crop should be considered, since S-oxidation,

which induced the observed increases, is a slow process and usually extend to the following crops.

The second experiment on maize

Tested response of maize (*Zea mays* L.) to foliar spray application of activated dry yeast and residual effect of S-application on previous onion crop. The experimental design was split plot with three replications.

Results

1. Residual effect of S application (600 kg/fa) on previous crop (onion) caused significant increases in maize growth (fresh & dry shoot weights) and N and P uptakes by plant and resulted in significant increases in grain, straw and total yields, as well as N& P grain uptakes and weight of 100 grains.

2. Foliar spray application of activated dry yeast significantly improved maize growth and increased N&P uptakes by plants and resulted in significant increases in grain, straw and total yields and weight of 100 grains.

3. The calculated increases in values of tested parameters induced by residual S-application were very close to those scored by yeast foliar application and sometimes even higher. The increases in shoot dry weight were 13.3 and 19.1%, respectively by residual-sulfur and yeast foliar application; whereas, the respective increases were 13.4% and 10.5% in grain yield and 13.4% and 12.3% in total maize yield.

4. The results indicate that the beneficial effect of S-application (600 kg/fa) on onion, resulting in 19.1% increase in bulbs yield extended to succeeding maize crop, and resulted in additional 13.4% and 13.4% respective increases in grain and total yields with no extra costs or labor need.