A comparative study of some methods used for assessing the avallabllity of n, pandk in soils

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The current research work was carried out to assess some methods used to estimate the available N, P and K in a wide range of different soil types in Egypt representing most Egyptian governorates (105 samples) to assign the most reliable method to assess the availability of these nutrients.The N availability was evaluated by using three different extractants, i.e. K-sulphate 1%, for soluble NO3-N and NH4-N, acetic acid 10 % (Bray method), for soluble NO3-N and acidified NaCI 10 %, for exchangeable NI-14-N.The P extractants used to assess P availability were: Olsen (0.5 N NaHCO3. pH 8.5), AB-DTPA, neutral AAc (?N), and adjusted-pH water (ADW) at pH 7.0, 8.0 or 8.5 and SER 1:1, 1:2 and 1:5 with each pH value.The K availability was assessed by using ;neutral AAc, AB-DTPA and ADW extractants that mentioned above.The study was also conducted with the purpose of comparing the efficiency of the ADW as an easy and simple extractant with the standard methods used for P and K extraction.Finally, the correlations between the extractable N, P and K and the uptake of these nutrients by barley plants grown on the studied soils were evaluated in a greenhouse experiment using simple correlation and stepwise regression analyses.The most important results could be summarized as follows:I- Nitrogen : 1-Much more NO3-N was extracted by the AcA 10% (Bray NO3-N) than by K-sulphate (KS) 1%, while the soluble NH4-N (by KS) accounted for a very small fraction of exchangeable NH4- N extracted by the acidified NaCI 10%, however the simple correlation analysis run between the different procedures used to extract the different N forms revealed that only the soil extractable NO3-N, either by KS or by AcA, showed significant correlations with plant N uptake (r =0.38** and 0.33** respectively).2-The simple correlation analysis run between soil extractable N forms and indigenous soil parameters also revealed that the highest significant correlations are those between soil total N and sand fraction -0.61”) followed by clay percentage (r=0.51**), soil OM content (r= 0.45**) and sand fraction (r= -0.30**). There was also negative significant correlation between sand fraction and NO3-N extracted by KS (r= -0.23*) and dry weight (r= - 0.44**). Soil contents of silt, clay and OM were correlated positively with plant dry weight and negatively with plant N content.3-When the soil indigenous soil parameters, soil N extractants and plant parameters were introduced to the stepwise regression analysis, the best composite equation describing the soil N availability status included plant dry weight and N content, sand fraction, soil salinity, Bray NO3-N, total soil Nand the exchangeable N l-14-N with a very high significant R2 value (0.97***). II- Phosphorus4-The amount of P extracted by ADW at different SERs and pH values was small compared to the other extractants. On average of all soil samples, the magnitude of the extraction method was in the order of NaHCO3> AAc > AB-DTPA > ADW. The extractable P was increased markedly by widening SER, meanwhile, the extractable P was slightly affected by pH of ADW extractants.5-Simple correlation analysis also revealed that the indigenous soil parameters; silt, clay and OM; were positively correlated with both plant uptake and dry weight, while both sand fraction and pH gave negative correlations. The extractable Olsen-P and AB-DTPA-P gave negative correlation with soil pH and positive correlation with soil OM, while the ADW-P did not show certen correlation with soil indigenousparameters6-For all the studied soil samples (105 samples), highly positive significant correlations between the extractable P and plant P uptake were obtained by both NaHCO3-P (r = 0.85”) and AB-DTPA-P (r = 0.72”), while, ADW showed less correlations (r = 0.56**-0.63**) and AAc method recorded the

lowest correlation 0.42**).7-The stepwise regression analysis gave further support to the previous results that insured the reliability of the Olsen-P extraction as one of the best extractants commonly used to assess P availability in alkaline soils. When the indigenoussoil parameter, P extractability and plant parameters were introduced, the best description of the P availability status (R2=0.97***) was achieved by means of a composited relation including Olsen-P, barley dry weight and plant P content.8-The effect of soil CaCO3 content on the extractable P showed that Olsen-P was superior to the other extraction methods when the soil contained total CaCO3 up to 8 % followed by AAc, AB-DTPA and ADW extractants, but the AAc method was superior when the soil contained > 8 % CaCO3. The extracted P by both NaHCO3 and AAc decreased by increasing soil CaCO3 content up to 8 %, but it increased again when the soil carbonate percentage was > 8%.9-Simple correlation analysis showed that both extractable Olsen-P and AB-DTPA-P were highly significant correlated with the Plant P uptake in soils containing CaCO3 up to 8 %, but when the soil-CaCO3 content was higher than 8 %, only Olsen-P and AB-DTPA-P gave significant correlation withplant P uptake.10-According to the soil CaCO3 content, the stepwise regression analysis yielded a very high significant correlation with Olsen-P but the R2 value decreased consistently as the soil CaCO3 increased (0.79*** to 0.70***) up to 8%, showing an inferiority to act as a quite reliable extract of soil available P in calcareous soils and AB-DTPA was the best substituteextractant, (R2-0.85***)11-Categorizing the tested soil according to their clay content ,revealed that the extractable P by all the tested extractants increased with increasing soil clay content up to 40% thendeclined. The simple correlation coefficients between the extractable P by the ADW, Olsen and AB-DTPA and plant P uptake showed significant correlation in the same trend being increased by increasing clay content up to 40%, then declined with superiority of Olsen-P method under the three claycontent classes.12- The stepwise regression analysis gave quite different composited relations for each clay category of the tested soils with R2 value decreased consistently from 0.88*** to 0.81*** and 0.75*** with increasing clay content from <30% to 30-40% and >.40% respectively. The light textured soils were best described with an equation including, soil sand fraction, extractable AB-DTPA-P and ADW —P at 1:2 SER and different pH values, while the medium textured soils were described with an equation including the Olsen-P and silt fraction, and the heavy textured soils with an equation included the extractable Olsen-P and AAc III- Potassium:13- The extracted K with ADW solutions was also less than those obtained by both AAc or AB-DTPA extractants. Over all the studied samples, the amount of extractable K by AAc and AB-DTPA were 591 and 565 ppm, respectively, while it ranged from 31.09 to 90.33 ppm by ADW extractants. The extractable K by ADW solutions was increased by widening SER and the increase was greater between 1:2 and 1:5 SER than between 1:1 and 1:2 SER. Meanwhile, no clear pH dependent relation in the range of pH examined was noticed.12214-Of the soil indigenous parameters studied, the soil pH was negatively correlated with K uptake and the extractable ADW-K, by the used methods while soil salinity correlated positively with the extractable ADW-K only. On the other hand, soil contents of silt, clay and OM were positively correlated with K uptake. dry weight and the extractable K byAAc and AB-DTPA.15-The simple correlation analysis revealed high significant correlations between the extractable K by different procedures and K uptake with superiority of the AB-DTPA-K which gave the strongest correlation (r=0.65**) followed by AAc-K (r=0.56**) while ADW showed relative less correlations.16-The stepwise regression analysis revealed a good composited relation describing K availability with highly significant value for R2 (0.97***) when soil indigenous parameters, K extractability and barley plant parameters were introduced. This relation included plant dry weight, plant K content and the extractable AB-DTPA-K with positive correlations and soil clay content with negative correlations.17-According to soil CaCO3 content, the extractable AB-DTPA-K and AAc-K were generally reduced by increasing soil-CaCO3 content. while ADW extractants showed nocertain trend.18-Categorizing the tested soil according to their CaCO3 content, the simple correlation analysis revealed highly significant correlation between K uptake and the extractable ADW-K in noncalcareous soils (<2% CaCO3) being decreased by increasing soil CaCO3 content up to 4%, abovewhich the ADW extractants failed to correlated with K uptake. The extractable AB-DTPA-K showed similar trend in the soil having CaCO3 up to 8%, however it was highly correlated (r=0.92**) with K uptake in calcareous soils (>8% CaCO3). The extractable AAc-K seemed to give constant

significant correlation with K uptake regardless the soil $CaCO_3$ content.19-According to the soil $CaCO_3$, the stepwise regression, quite different composite relations with each category were obtained showing the essentiality of using distinct procedure for assessing the soil K availability. The best relation that describe the soil K statues in soil containing up to 4% $CaCO_3$ included the extractable ADW-K at pH 8 and SER 1:1 or 1:2 with R2 0.70*** - 0.79***, while the extractable AB-DTPA-K only was involved in the regression equation that describes K statues in calcareous soils (>8% $CaCO_3$) with the highest R2 value (0.85***), showing that the AB-DTPA method could be substituted for the commonly used AAc, as reliable method for assessment of K availability in calcareous20-Categorizing the tested soil according their clay content, the extractable ADW-K was reduced by increasing soil clay content, while the extractable AAc-K showed the reverse. Meanwhile, the extractable AB-DTPA-K showed no certain trend.21-The simple correlation coefficient between the extractable ADW-K and K uptake was progressively improved with increasing soil clay content with the highest r values (r-A.78** - 0.81**) in heavy clay soils, however the reversewas observed with the extractable AAc-K.which showed less r value (0.39**). So, the ADW extractants may be used as a substituent extractant of AAc in heavy clay soils (>40% clay). Meanwhile, AB-DTPA extractant could be suggested as a reliable method for assessing K availability with increasing its reliability by increasing soil clay content.22- The stepwise regression analysis revealed the contribution of soil clay content in the composite relation in soils having >30% clay. The results confirmed those optioned with the simple correlation analysis, since the extractable AB-DTPA-K was involved in the composite relation describing the K status in soils containing 30-40% clay and this was true for the extractable ADW-K (at 1:5 SER and pI-18.5) in heavy clay soils.