Efficient fertilizing system of vulgaris beans growing under different conditions

Samir Abdalla Mohamed Moussa

String bean, PhaseollIS vulgaris, L. is a new cultivar has a goodpotential to be exported and there is a great demand on it especially from theEuropean comunity. These new variety alone produce a high percentage ofstraight pods in the Extra and Fine categories which enjoy the best marketprices. Thus export of this variety becomes very important to increase thenational revenue.The aim of this investigation was to study:1) The response of Pbaseolus vulgaris plants to inoculation understerilized condition as well as the effect of N application to inoculatedand uninoculated plants on nodulation and plant growth.2) The ability of Phaseolus vulgaris plants to form nodules under naturalsoil condition and their ability to utilize the atmospheric nitrogen.3) The effect of N source, rate and method of application on the commercialexportable yield of the Extra and Fine categories.4) The efficacy of ammonium nitrate fertilizer when applied through drip oras surface continuous band under submersion irrigation conditions.To accomplish the first and second objectives, laboratory andgreenhouse experiments were conducted.I. LABORATORY EXPERI •••ENTSeeds of Puseolu, vulgaris were pl~ted in sterilized sand culture(Leanard Jar system), inoculated or uninoculated with the appropriateRhizobium culture (strain No. 3612). Nitrogen was applied at the rate of0,165 and 33 mg N/kg sand to the inoculated and uninoculated treatments.The results obtained from this experiment can be briefly summarized asfollows:1. The plants fallled to form any nodules when planted in sterilized soil freefrom Rhizobium bacteria, but the nodules were formed afterinoculation with effective strain of Rhizobium phaseoU.2. Inoculated treatments without N application exhibited a relatively highplant growth with highest nodulation i.e, number and weight of nodules.Nitrogen addition to inoculated treatments decreased not only number ofnodules/plant but also the total and individual weight of nodules. Thenumber of nodules/plant was reduced from 136 in absence of nitrogen to38 with the rate of 16.5 mgN/kg and to 6 with the highest rate of nitrogen(33 mgN/kg).3. The root dry weight was increased significantly with increasing N rate.However, the effect of inoculation on dry weight of root was negative.4. The shoot dry weight was increased significantly with increasing Napplication to inoculated and uninoculated plants. At the rate of 0 and16.5 mg N/kg, the inoculated plants produced high shoot dry weightcomparing with uninoculated ones.5. Total N and N03-N in blade were increased significantly as a result ofincreasing the applied nitrogen and the increase. was higher in theinoculated plants provided that the rate of nitrogen did not exceed 16.5mgN/kg.II. GREENHOUSE EXPERIMENTNatural and fumigated sandy soil was used in this experiment. Nitrogenwas applied to the pots before sowing at the rate of 0, 16.5 and 33 mgNlkg.Phaseoills vulgaris seeds were planted in soil inoculated or uninoculatedwith the appropriate Rhizobium culture (strain No. 3612).The following is a brief summary of the results obtained:1. Plulseolus vulgaris plants in all investigated treatments failed to formany nodules.2. Soil organisms and antagonistic factors had no inhibitive effect on theRhizobium phaseoli indicating that such a failure could beundoubtedly attributed to the high content of available native soil-N, orpH effects.3. It is worthy to conclude that Phaseolu, vulgaris pants is not able to usethe atmospheric nitrogen as a result of its failure to form any nodulesunder common natural soil condition. Thus the addition of N toPhaseolu, vulgaris plants is very important to increase theproductivity than other leguminous crops.To achieve the third and fourth objectives two field experiments wereexecuted.III. FIELD EXPERIMENTSA) Submersion Irrigation experiment:The aim

of this study was to detrnnine the most effective N source, rateand method of application on plaat growth, yielding ability and physical andchemical characteristics of pods. The N sources (ammonium nitrate,ammonium sulphate and urea) were applied at rates of 33 and 66 kg N/fedthrough the two application methods namely surface continuous band (SCB)and surface localized band (SLB).The results obtained from this experiment can be summarized in thefollowing:a) Plant growth:1. Plant height was not affected significantly by N source, rate and method ofapplication in the two growing seasons.2. Plants fertilized with ammonium nitrate had the highest number ofleaves/plant, followed by those received ammonium sulphate, while theother treated with urea had the lowest number of leaves, in both seasons.Furthermore, increasing N rate resulted in significant increase in numberof leaves/plant in both seasons with all N treatments.3. The effect of N source on leaf area was followed this order: urea >ammonium sulphate > ammonium nitrate. Nitrogen rate showed asignificant effect on leaf area only in the second season.4. The highest dry weight of plant was obtained with ammonium nitrate andammonium sulphate which significantly did not exhibit any differencecompared each other in the first season. The lowest dry weight of plantwas recorded when N was applied as urea fertilizer with significantdifference in both seasons compared to the other two sources. IncreasingN fertilization dose resulted in a significant increase in dry matterproduction with all N sources dwing the two seasons.5. Application of N through surface continuous band method significantlyincreased the dry weight of plant comparing with surface localized bandmethod.b) Yielding ability:1. The yield of Extra pods was affected positively and significantly by Nsource. Ammonium nitrate was the superior and urea was the inferior.The yield was increased as the rate of N application increased except withurea, whereasethe yield was decreased by increasing the rate. This wastrue in both growing seasons.2. The effect of N source on Fine pods yield was followed the followingorder: ammonium nitrate>urea> ammonium sulphate with significantdifference compared to each other, in both growing seasons. The highestvalues of Fine pods yield, in both seasons, were concomitant with thehighest level of applied nitrogen except with urea the high dose ofnitrogen significantly retarded the pods production.3. The highest yield of Bobby pods was concomitant with ammoniumsulphate source, while the lowest was recorded with ammonium nitrate.Concerning the effect of rate, there is a significant decrease in the yieldof Bobby pods as a result of increasing the rate of ammonium nitrate andammonium sulphate. However, the yield was increased sharply withincreasing the rate of mea. Similar effects of ammonium nitrate and ureaon the yield were obtained in the second season, but increasing the rate ofammonium sulphate increased the production of Bobby pods.c) Physical and chemical characteristics of pods:* Physical characteristics of pods:1. The lowest average length of pods was recorded when N was applied asammonium nitrate with significant difference compared to the other twosources (ammonium sulphate and urea) which significantly did not exhibitany difference compared to each other, in both seasons. The pods lengthof Extra category was not affected significantly by N rate in the twogrowing seasons.2. The least values of length trait were obtained after anunonium sulphateapplication with significant difference compared to the other two sources.Nitrogen rates did not induce any significant effect on length of Finepods, in both seasons.3. The effect of N source on Extra pod diameter was followed this order:ammonium nitrate> ammonium sulphate> urea.4. The most effective N source on Fine pod diameter was ammonium nitratefollowed by urea and the least effective was ammonium sulphate.5. In both growing seasons, the higher values of Extra and Fine podsdiameter were significantly concomitant with the highest level of theapplied nitrogen.6. The effect of N source on Extra pod dry weight was followed this order:ammonium nitrate > ammonium sulphate> mea. Increasing the dose ofapplied nitrogen was accompained by significant incIcase of about 7.4%in dry weight of Extra category.7. The following order describes the effect of N source on Fine pod dryweight: ammonium nitrate > urea > ammonium sulphate. Increasing Nfertilization dose resulted in a significant increase in dry matterproduction during the two seasons.** Chemical characteristics of pods:1. The fibers content in Extra pods was ranged from 0.01 to 0.04%. NeitherN source and rate nor method of application had a marked effect onfibers content in Extra pods, in both growing seasons, indicating that thiscategory is free from fibers.2. The fibers content in Fine pods was ranged from 3.9 to 5.8%. The effectof N source on fibers content of Fine category was followed this order:ammonium sulphate> urea> ammonium nitrate with significantdifference compared to each

other during the two growing seasons.Concerning the effect of N rate, there is a significant decrease in thefibers content of Fme· pods as a result of increasing the rate of N in bothseasons. Moreover, the surface localized band method gave a relativelyhigh effect on fibers trait, in the two growing seasons.3. The fibers content in Bobby pods ranged from 29.9 to 60%. Thereforethis category is practically unexportable because the fibers content wastoo high .4. The effect of N source on fibers content of Bobby category was followedthis order: ammonium sulphate > urea > ammonium nitrate. Increasingthe nitrogen rate resulted in a significant decrease in the fibers bootent ofthis category in both seasons.5. The effect of N source on protein content of Extra pods was followed thisorder: ammonium nitrate > ammonium sulphate > mea. Nitrogen ratesdid not induce any significant effect on protein content of Extra pods, inboth seasons.6. The surface continuous band method gave the superior results withsignificant effect compared with the other method of application in bothseasons.7. The effect of N source on protein content of Fine pods was followed thisorder: ammonium nitrate > urea > ammonium sulphate with significanteffect in both seasons.8. The protein content in Fine pods was decreased significantly withincreasing N rate, in the first season. However, a poor relationshipbetween protein content and N rate was found in the second one.9. The protein content was affected significantly by the methods ofapplication, only in the first season. Furthermore, the surface continuousband method gave a relatively high effect on protein content of Finecategory, in both growing seasons.Generally, application of ammonium nitrate fertelizer at a rate of 66 kgN/fed through surface continuous band method was commercially the best ofall fertelization treatments. Such a treatment gave the highest commercialexportable yield with quite excellent pod characteristics during the twogrowing seasons.B) Drip Irrigation experiment:This investigation aimed at studing the efficacy of anunonium nitratefertilizer when applied through drip irrigation or as surface continuous bandunder submersion irrigation systems. The ammonium nitrate was applied atthe rate of 0, 33 and 66 kgN/feddan.The results of this experiment could be summarized as follows:a) Plant growth:1. Plant height was increased significantly as the rate of N increased from 0to 33 kgN/fed under the two irrigation methods. Increasing N rate from33 to 66 kgN/fed resulted in a slight decrease in-plant height when the Nwas applied through the drip irrigation system.2. The plant heights in the drip irrigated plots were increased over thesubmerged ones by about 7.5, 15.6 and 6.4% for the 0,33 and 66 kgN/fed, respectively.3. The leaf area was increased significantly with increasing N rate and thehighest leaf area was obtained with the highest Nrate (66 kg N/fed) underthe two irrigation regimes.4. The dry weight of plant exhibited a positive response towards dripirrigation system of about 7.5 and 10.0% for the 33 and 66 N dose,respectively, as compared with those irrigated by the other one.5. The number of leaves/plant was increased significantly with increasing theapplication rate and the highest number was obtained with the highest Nrate (66 kgN/fed) with the two irrigation systems.b) Yielding ability:The drip irrigation system exhibited a positive effect on the yield ofExtra and Fme categories showing an incIeasc of about 24.8 and 21.3% forthe 33 kgNlfed and 13.8 and 26.2., for 66 kgN/fed over the plants ferti1iz.edwith the same doses of N fertilizer under submersion irrigation regime.However, the total yield of submerged plants was higher than that of dripirrigated ones because of the occurrance of undesirable Bobby category.c) Physical and chemical characteristics of pods:* Physical characteristics of pods:1. Regarding the drip irrigation system, application of N fertilizer to plantsdid not induce any significant effect on the average length of Extra podsin all treatments. However, significant increase was observed withincreasing N rate in case of using the submersion irrigation regime.2. The pod length of the Fine category was increased significantly withincreasing N rate under drip and submersion irrigation conditions.3. The 33 kg N/fed was the best N dose affecting the length and diameter ofExtra pods through drip irrigation system which accompained with thehighest length (10.0 em) and quite good diameter character (6.5 rom).However, 66 kgN/fed was the most effective dose on diameter and lengthof Extra pods under submersion irrigation system as wll as on the samecharacter of the Fine pods under both regimes.4. There were a continuous increaments in dry matter of Extra and Finepods with increasing N rate from 0 to 66 kgN/fed under both irrigationconditions. However, pod dry weight of drip irrigated plants was higherthan that of submerged ones.** Chemical characteristics of pods:1. There is a gradual decrease in fibers content of Extra and Fine withincreasing N rate under both irrigation systems. Fine category producedmore

fibrous pods, while those of Extra grade contained the least amountof fibers. This was true under the two irrigation systems.2. Extra pods was the richest category in their protein content The proteincontent in pods was increased significantly with increasing N dose and thehighest value was obtained with the highest N rate (66 kgN/fed) with thetwo irrigation systems. Moreover, the superiority was recorded for thedrip irrigation regime.3. Extra pods was the richest category in the chlorophyll content. Therewere a significant increase in chlorophyll content in Extra and Fme podswith increasing the level of the applied nitrogen under both irrigationsystems.4. The carbohydrate content in Extra. pods of drip irrigated plants wereincreased over submerged ones by about 3.6, 8.5 and 12.2% for 0, 33 and66 kgN/fed, respectively. However, Fine pods produced under dripirrigation regime was lower in their carbohydrate content than that ofsubmerged ones by about 1.9. 7.9 and 16.5% for 0,33 and 66 kgN/fed.respectively.d) Nutrient content of Phaseolus VUlgarIs plant:The results indicated that blades were the best representative organ forthe nutritional status in plants. Blades analysis showed that the 66 kgN/fedtreatment was the best one which increased the concentration of N,P. Ca andMg; but decreased K concentration.