INTERNATIONAL JOURNAL OF PLANT, ANIMAL AND ENVIRONMENTAL SCIENCES
IJPAES
Volume-6, Issue-2, April-June-2016 Coden: IJPAJX-CAS-USA, Copyrights@2016 ISSN-2231-4490
Received: 8th Feb-2016 Revised: 25th Feb 2016 Accepted: 27th Feb 2016
Research article

STUDY OF GROWTH AND YIELD OF CLUSTER BEAN IN ALKALINE SOIL USING ORGANIC MANURE AND BIOFERTILIZERS

Duraraj P[a*], ManiarasanU[b] and Nagarajan N[b]

[a]District Watershed Development Agency, Tiruchirapalli
[b]Department of Ancient Science, Tamil University, Thanjavur

ABSTRACT: The present study could be viewed as Growth and yield of plants in the stress soil. To overcome the stress effect we have employed organic manures and biofertilizers thus facilitating the growth and yield of the crop plant. Thus we expect that the organic manure (Pressmud) and biofertilizers could change the properties of soil and if the practice is continued for a period of time the soil could be sustain ably changed. The yield of the cluster bean could be increased 10 fold if Organic manures and Biofertilizers are applied in adequate quantity. The yield of cluster Bean could be reduced to 12.8% of the ideal yield in Alkaline soil. When we use Press Mud, Farm Yard Manure and Consortium of Biofertilizers the yield in the Alkaline soil could be brought up to 66.6% that is about 6 fold of the Alkaline soil.
Key words: Stress Soil, Biofertilizer, Pressmud, Alkaline soil, cluster been

*Corresponding author: Duraraj P. [a]District Watershed Development Agency, Tiruchirapalli,
E-mail: durairajphd@gmail.com

INTRODUCTION

Natural soils differ considerably in their constituents and reaction. These differences are reflected in the vegetation or crops they carry which obviously determine either the land is fertile or sterile. The lands are affected mainly by a) soil salinity, b) alkalinity, c) acidity, d) water scarcity e) nutrient deficiency etc. Soil alkalinity is particularly serious in subsoil because it may cause poor root development, drought-susceptibility and inefficient use of nutrients in these deeper zones [1]. Alkaline soil toxicity is a very insidious problem; it may reduce fertilizer and water use efficiency Furthermore, alkaline soil having similar pH value may cause different mineral stress problem in a given plant genotype. Alkalinity may also promote or inhibit the survival and function of rhizobia, mycorrhizae, and other microorganisms [2]. When the pH of the soil rises above 8.0, the availability of nutrients such as P, K, Ca and Mg are restricted.

There are certain microbes, which help the plant to derive the nutrient form the soil or convert the minerals to available forms. Such microbes are called Bio-fertilizers. The term "BIOFERTILIZER" denotes all the nutrient inputs of biological origin for plant growth[3] Here biological origin refers to microbiological process synthesizing complex compounds, which are again taken up by the plants.[4]; [5]).*Azospirillumlipoferum* is found to be very active under Tamil Nadu conditions as compared to other species. It is found to increase the yield of crops like sorghum, pearl millet, ragi, gingili, cotton, sunflower, sugarcane.

Many microorganisms present in the soil or in the rhizosphere of plants as free-living forms are capable of converting insoluble forms of phosphorus into soluble forms, which can be directly utilized by plants [6]; [7]. These are in general called phosphorus solublisingmicro-organism, which include bacteria such as Bacillus and Pseudomonas and fungi such as Pencillium and *Aspergillus*. Similarly certain fungi, which are associated symbiotically with roots called VA-mycorrhizae, are present outside the roots forming structures called ectomycorhizae capable of mobilizing phosphorus in to the plants. Phosphorus solubilising bacteria have been extensively used as biofertilizers [8]. It has been successfully proved that ArbuscularMycorrhizal (AM) fungi have the potential of supporting the plant in establishing and growing of the plants.

Sugar factory generates large quantity of, press mud.The advantages of using sugarcane pressmud for soil application is its low cost, slower release of nutrients, presence of trace element, high water holding capacity and mulching properties [9]. Consequently efforts are to be made to support the plants first to withstand the adverse conditions and then in their nutritional requirements so as to achieve the expected economic yield. The means should be sustainable and cheaper and at the same time should also amend the soil suitable for plant growth. Physical and chemical means may not provide cost effective, lasting solutions. One of the best means to achieve our target is appropriately using microbial biotechnology. Three bio-inoculants are used in 2^3 factorial designs so as to understand their individual and associative effects. The three bio-inoculants chosen are AM fungi and PSB and Azosprillum.

Cluster bean *Cyamopsistetragonoloba* (L.)

It is multipurpose crop plant of arid or semiarid areas. It may enhance soil productiveness by fixing atmospheric nitrogen for its own requires and also for the succeeding crop. Even though is a minor crop but due to is an important cash crop for industrial gum production [10].

Based on these facts the following objectives are envisaged in the present study.

1. Germination of Cluster bean in alkaline and normal soil conditions
2. Comparison of seedling growth and Biochemical variation in normal and alkaline soil conditions.
3. Effect of Organic and Bio fertilizers both individually and in combinations on alleviating the stress and improving the productivity.

MATERIALS & METHODS

Plant Meterial

Cluster bean (*Cyamopsistetragonoloba* L.)

Organic Manure

1. Pressmud (PM), 2. Farmyard manure (FYM**)**

Bio-fertilizer

Consortium of VAM + Azosprillum + Phosphbacterium

Site of Experiment

Selected site was divided into eight blocks, each block for one treatment according to 2 level, 3 factor factorial design presented in Table-1.

Table-1: Details of the Treatments according to the 2 levels three factors factorial design

Treatment No	Farm Yard Manure	Pressmud	Biofertilizer	Given conditions
T_1	×	×	×	Exclusive Stress effect
T_2	×	×	√	Effect of Biofertilizer
T_3	×	√	×	Effect of Pressmud
T_4	×	√	√	Combined effect of Pressmud & Biofertilizer
T_5	√	×	×	Effect of Farm Yard Manure
T_6	√	×	√	Combined effect of Farm Yard Manure & Biofertilizer
T_7	√	√	×	Combined effect of Farm Yard Manure &Pressmud
T_8	√	√	√	Combined effect of Farm Yard Manure &Pressmud & Biofertilizer

Phase–I: Germination Studies

20 seeds were sown in each plot after treating the soil according to the design. Number of seeds germinated was recorded on each day after sowing.

Phase–II: Seedling Growth

On 20^{th} day 15 seedlings were carefully removed ensuring sufficient distance between the remaining 5 seedlings. From the seedlings harvested the various physiological and exomorphic variables were studied to assess the effect of Organic and bio fertilizers.

RESULTS & DISCUSSION

The present study could be viewed as growth and yield of plants in the stress soil. Preliminary experiments were conducted with different proportions of Pressmud and Farmyard manure to determine the amount of organic manure to be used in the experimental plots (The proportion of the pressumd or farmyard manure is maintained as 2%) Germination is the first phase of plant life. Germination phase and the seedling stage are very sensitive phases and a crop can grow and yield successfully only if is successful in this phase. Besides germination and seedling growth are very easily affected by external (adverse) environmental factors such as water, temperature, pH of the soil etc. The rate germination in the stress soil and in different treatments is expressed in table-2. Germination was observed from third day onwards and completed on ninth day. The germination ranged from 85 to 100 % that means the germination was not much affected by the salinity. However the death of sapling in the stress soil indicates that establishment of the saplings in the saline soil could be challenging.

Table-2: Germination of Cluster Bean Seeds in various treatments (out of 20 seeds).

Treatments	Days after sowing								
	1	2	3	4	5	6	7	8	9
T_1	0	0	2	12	15	16	17	19	16*
T_2	0	0	7	13	15	16	16	16	17
T_3	0	0	5	13	17	18	19	20	20
T_4	0	0	15	17	18	18	18	18	18
T_5	0	0	9	9	12	14	15	15	15
T_6	0	0	13	16	17	17	17	17	18
T_7	0	0	13	15	18	18	18	18	18
T_8	0	0	6	6	11	18	18	20	20

*Remaining after death of the seedlings

Seedling growth

Seedling phase is a crucial phase in the life of a plant as it is very tender and highly susceptible to adverse environment. Thus growth of the seedlings is a good parameter to ass the severity of the stress. Effect of the stress on the seedling growth could be assessed in terms of exomorphic variables and very sensitive parameters like chlorophyll content. The observations on the seedling growth in terms of shoot length and root length are given in Table–3. The alkalinity has significantly affected the growth of both shoot and the root (Plate-1). Only about 50% growth is observed in the stress soil compared to the amended soil – T8. Appreciable growth has been recorded in T6(FYM and Biofertilizer), T7 (FYM &Pressmud) and T8 (FYM + Pressmud + Biofertilizer), which indicates that FYM is the most essential requirement which could be supplemented with Pressmud or Biofertilizer.

These observations indicate that

i) Alkalinity will severely affect the growth and establishment of the seedling
ii) FYM is the most ideal resource to mitigate the adverse effects of salinity
iii) FYM is an ideal material to amend the alkaline soil and support the growth of the plant.

Table-3: Seedling growth in different treatments on 20 the day

Treatment	Plant height (inch)	No.of branches	Inter node length (inch)	No. of Nodes
T_1	18	1	1.0	9
T_2	24	1	1.5	14
T_3	25	2	1.8	15
T_4	28	3	2.2	17
T_5	21	3	1.5	10
T_6	27	2	2.1	17
T_7	26	2	2.0	16
T_8	32	3	2.8	18

The last phase of study is the reproductive or yield phase. Observations were made on 50th day on the various vegetative and yield variables. The plant height, number of branches number of nods, and inter nodal length during flowering is given in table 4. In the stress condition the height is only 18 inches where as it is about 32 inches in plants grown in stress soil but treated with organic manure and biofertilizers. Similarly all the parameters related to the shoot are very much affected in the alkaline condition.

Table – 4: Vegetative growth on 50th day in various treatments

Variable	Treatments							
	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8
Shoot length - cm	3.12±.05	4.25±0.15	3.6±0.2	3.14±.15	5±0.28	6.5±0.31	6.6±0.32	6.0±0.62
Root Length - cm	5.32±0.3	8.25±0.4	9.0±0.55	9.5±0.65	7.5±0.55	9.75±0.7	8.25±0.6	10.0±.75
Total seedling length - cm	5.44±0.2	12..5±0.3	12.6±0.3	12.64±0.5	12.5±0.45	16.25±0.6	14.85±0.5	16.0±0.70
Shoot/Root ratio	0.59	0.51	0.4	0.33	0.67	0.67	0.8	0.6

Our ultimate aim is to make unproductive land productive. With regard to cluster bean the economic yield is pods in terms of weight. The number of pods in each plant, pod length and pod weight determine the yield of the crop. The number of pods per plant, pod length and seeds per pod are expressed table-5 (Plate-1). Application of organic manure and biofertilizers has increased the number of pod per plant to 5 fold. Similarly the treatment has increased the pod length to about 2 fold. Thus judicial application of organic manure and biofertilizers will certainly convert the unproductive land into productive and increase the yield by 10 fold. Thus the present study indicates that proper selection of the organic manure and the biofertilizers would certainly help us to profitably use the waste lands and obtain high economic yield

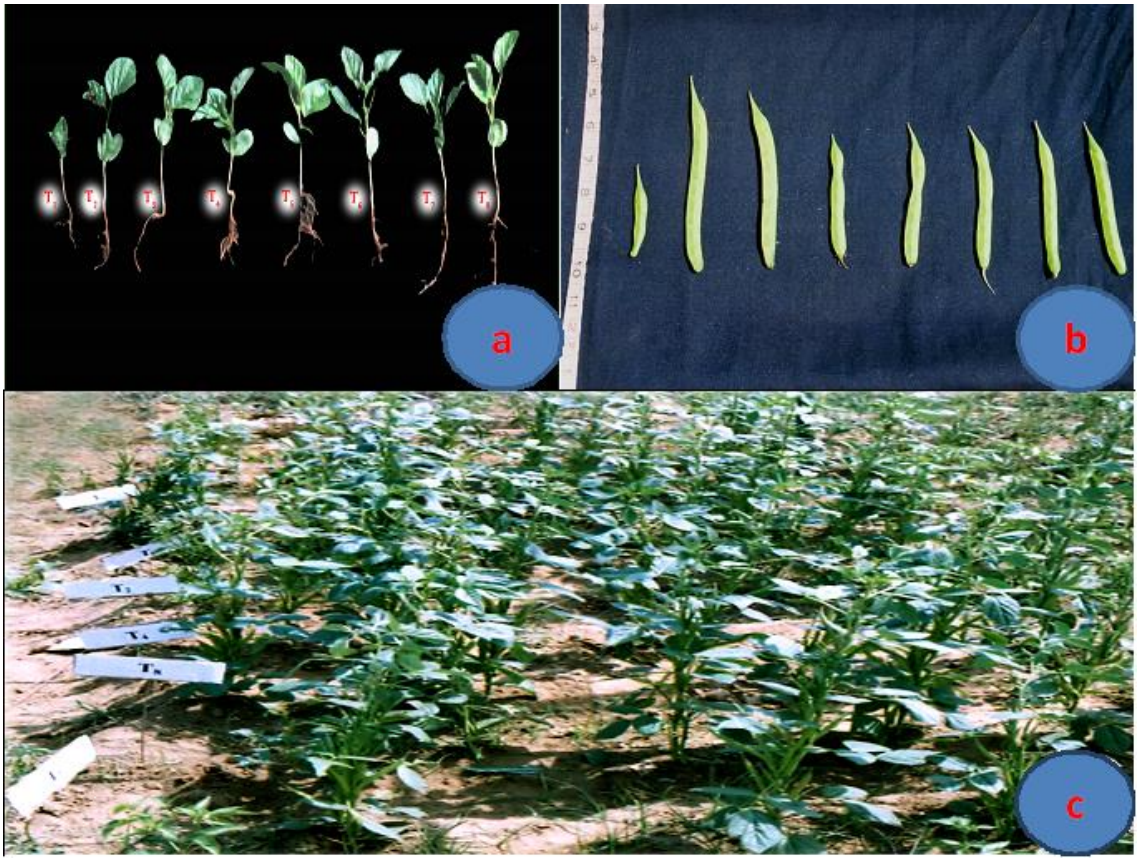

Plate-1: a. Growth of both shoot and the root, b. Pod length, c. Experimental plot

Table – 5: Economic yield on 50th day

Treatment	No fruits	Fruit length (inch)	No. seeds
T_1	10	2.6	3
T_2	32	4.0	6
T_3	40	4.4	8
T_4	45	5.5	10
T_5	25	3.5	6
T_6	44	5.1	9
T_7	43	4.5	9
T_8	50	5.8	12

Yield Modeling in Alkaline soil With Organic Manure and Biofertilizers

As the study was conducted in Experimental conditions in limited plot size a mathematic modeling was derived fixing the following conditions

- Plant spacing is 1'6" x 1'0"
- There would be 208 rows and 140 columns in one acre
- Total number of plants in one acre would be ~ 29,000
- Yield per acre in tons = $\frac{\text{Yield per plant} \quad \mathbf{x} \quad 29{,}000}{1{,}000 \quad \mathbf{x} \quad 1{,}000}$

Under these conditions and from the data collected from the field the probable yield under various treatment conditions is expressed in Table- 6.

Table-6: Modeling for yield potential of cluster been in alkaline soil and in various treatments with organic and biofertilizers

Treatment	Treatment conditions	Yield per plant grams	Yield per Acre In tons	% of ideal yield
Ideal	Good soil with optimum fertilizers and irrigation	300	8.7	------
T_1	Alkaline soil	40	1.16	13.3
T_2	Alk. Soil + BF	128	3.7	42.5
T_3	Alk. Soil. + PM	160	4.6	52.9
T_4	Alk. Soil + PM + BF	180	5.2	59.8
T_5	Alk. Soil. +FYM	100	2.9	33.3
T_6	Alk. Soil +FYM + BF	176	5.1	58.6
T_7	Alk. Soil FYM + PM	172	4.9	56.3
T_8	Alk. Soil + PM + FYM + BF	200	5.8	66.7

The results indicate that

i) The yield under ideal conditions (obtained from the literature) could be ~9 tons per acre.
ii) In T_1 the yield could be only 1.16 tons per acre i.e., only 12.8% of the ideal yield
iii) When we use Press Mud, Farm Yard Manure and Consortium of Biofertilizers the yield in the Alkaline soil could be brought up to 66.6% that is about 6 fold of the Alkaline soil.
iv) If we optimize the quantity of these organic manures and Biofertilizers and supplemented with deficient nutrients we can even achieve more yield

CONCLUSIONS

A. Wasteland is a threatening concept, which has to be addressed before the problem becomes irreversible
B. Efforts should be made to develop technologies, which is cost effective and affordable to make the wasteland management productive.
C. One of the eco-friendly means of wasteland management is employing organic manure and biofertilizers.
D. Organic manures and Biofertilizers help in better seedling growth and establishment in the field.
E. Thus the present study gives hope that the waste land could be made productive and earns good money if we judiciously apply the manures and fertilizers and Cluster Bean is one of the promising plants to cultivate in such soils.

REFERENCES

[1] Ayers, R.S., and Westcot, D.W. 1985. Water quality for agriculture. FAO Irrigation and Drainage Paper 29, FAO, Rome.

[2] Paul D, Nair S (2008) Stress adaptations in a plant growth promoting rhizobacterium (PGPR) with increasing salinity in the coastal agricultural soils. J Basic Microbiol 48(5):378–384.

[3] Lugtenberg B, Chin-A-Woeng T, Bloemberg G (2002) Microbe-plant interactions: principles and mechanisms. Antonie van Leeuwenhoek 81:373–383.

[4] Mayak S, Tirosh T, Glick BR (2004) Plant growth-promoting bacteria that confer resistance to water stress in tomatoes and peppers. Plant Sci 166:525–530.

[5]Egamberdieva D, Kucharova (2009) Selection for root colonising bacteria stimulating wheat growth in saline soils. BiolFertil Soils 45:563–571.

[6] Bull CT, Weller DM, Thomashow LS (1991) Relationship between root colonization and suppression of Gaeumannomycesgraminis var. triciti by Pseudomonas strain 2–79. Phytopathology 81:954–959.

[7] Devliegher W, Syamsul Arif MA, Verstraete W (1995) Survival and plant growth promotion of detergent-adapted Pseudomonas fluorescens ANP15 and Pseudomonas aeruginosa 7NSK2.Appl Environ Microbiol 6:3865–3871

[8] Boucher, 1999. Effect of arbuscularmycorrhizal colonization of four species of Glomus o physiological resonses of maize. J. Plant Nutr. 22(4-5):783-797.

[9] Bhosale P.R, Chonde S.G, Nakade D.B, and Raut P.D ISCA Journal of Biological Sciences Vol. 1(1), 35-41, May (2012)

[10]Hymowitz T, Matlock RS.Guar in the United States.Oklahoma Agricultural Experiment Station Technical Bulletin.1963; 611:1–34.

INTERNATIONAL JOURNAL OF PLANT, ANIMAL AND ENVIRONMENTAL SCIENCES

ISSN 2231-4490

International Journal of Plant, Animal and Environmental Sciences