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Effect of Cyanobacteria and Mycorrhizal Biofertilizers with Chemical Fertilizers in *CAJANAS CAJAN* (Maroti)

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Abstract: ***The rhizosphere is the zone surrounding the roots of plants in which complex relations exist among the plant, soil microorganisms and the soil itself. Arbuscular mycorrhizal associations are integral, functioning parts of plants roots and are widely recognized as enhancing plant growth. Isolation of the indigenous and presumably adapted VAM fungi can be a potential biotechnological tool for inoculation of plants for successful restoration of degraded ecosystem. The study evaluated the response of Cajanas cajan to Glomus fasciculatum, Nostoc paludosum of different strains and chemical fertilizers. The result demonstrate the significantly increase in the plant biomass, % of root colonization, no. of vesicles, no. of spores in the dual inoculation of comparison to single inoculation.***

Keywords: *Cajanas cajan, Glomus fasciculatum, Nostoc paludosum,* Arbuscular mycorrhiza

1. Introduction

Root colonization by vesicular arbuscular fungi helps in host plant and nutrition (Mosse 1968, Menge et al 1982, Phillips and Hayman 1973) and due to their potential for crop improvement. A symbiotic relation between plant and microbes represents the climax of intricate relation which refers to an association of living organisms that benefits both the partners enabling them to survive, grow and reproduce more effectively. The endomycorrhizal fungi produce branched hyphal structure within the plant cell. This infection creates an absorptive structures with a very high surface area for transfer of nutrients between the plant and fungus.

Role of biofertilizers is improving the soil fertility has been emphasized by number of workers. Cynobacterial biofertilizer is an easily manageable and self generating system which not only provides nutrients to plants in terms of nitrogen, amino acids and growth promoting substance but also improves soil health and texture, (Bertocchi et al 1990).The dual inoculation of VAM and blue green algae proved beneficial not only in terms of economizing N and P fertilizer by 50% but also improved the growth of plant. The study has been undertaken to evaluate the tolerance level of heavy metal by *Glomus* and *Nostoc* after absorbing such metals both were combined along with chemical fertilizers to some extent to show improved results, in growth parameters.

2. Material and Method

The culture of *Glomus fasciculatum* was brought from the Tata Energy Research Institute (TERI) New Delhi and mass cultured under grasses in open clay pot while different heavy metallic Zn, Cu, & Cd strains of *Nostoc paludosum* were prepared in the laboratory and Zn, Cu, Cd tolerance level for *Glomus fasciculatum* was tested in the soil. The mycorrhizal and cyanobacterial biofertilizers were inoculated in soils of seedling plants. The chemical fertilizers were given to each plant in following week. The proportion of N,P,K to soils were different with different plants as ICAR. The chemical fertilizers were given in different ratio with and without combination of mycorrhizal , cyanobacterial biofertilizer

Glomus fasciculatum (tolerance level)		*Nostoc paludosum* (tolerant strain)	
Zn – t	400 mg kg $^{-1}$	Zn – t	9.0
Cd – t	800 mg kg $^{-1}$	Cd – t	0.5
Cu – t	1500 mg kg $^{-1}$	Cu – t	0.7

I. Chemical fertilizer Treatment

N level	symbol	P level	Symbol
0 Kg N/ha	N_0	0 Kg P/ha	P_0
5 Kg N/ha	N_1	10 Kg P/ha	P_1
10 Kg N/ha	N_2	20 Kg P/ha	P_2
15 Kg N/ha	N_3	30 Kg P/ha	P_3
20 Kg N/ha	N_4	40 Kg P/ha	P_4

No treatment of glomus &
No treatment of Nostoc = T_0
No treatment ($T_0 + N_0 + P_0$) = T
Treatment with *Glomus* (w, Cu-t , Zn-t , Cd-t) = T_1
Treatment with *Nostoc* (w, Cu-t , Zn-t ,Cd-t) = T_2

II . Mycorrhizal biofertiliser and cynobacterial treatment

Treatment with ($T_1 + T_2$) = T_3

III . Mycorrhizal biofertiliser , cynobacteria and chemical fertililizer

Treatment with ($T_3 + N_1 + P_1$) = T_4
Treatment with ($T_3 + N_2 + P_2$) = T_5
Treatment with ($T_3 + N_3 + P_3$) = T_6

Treatment with (T_3 + N_4 + P_4) = T_7
Treatment with (N_4 + P_4) = T_8

3. Results

Table 1: Effect of wild Cu – t , Zn – t , Cd – t strains of Glomus fasciculatum , Nostoc and chemical fertilizers on plant height (cm) of Cajanas cajan.

Treatment	T	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8
W	158.2	160.1	166.6	166.5	183.4	171.4	181.2	177.4	172.1
Cu – t	158.4	168.5	168.8	179.2	183.4	172.4	183.4	178.2	173.1
Zn – t	160.2	170.3	170.9	180.3	190.8	190.9	180.3	186.4	180.2
Cd – t	160.6	164.2	163.9	167.5	176.9	166.1	175.4	175.8	172.9
Mixed Metallic	163.2	168.1	170.9	173.4	176.6	173.3	178.9	173.6	175.4

Table 2: Effect of wild Cu – t , Zn – t , Cd – t strains of Glomus fasciculatum, Nostoc and chemical fertilizers on number of pods per plant of Cajanas cajan

Treatment	T	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8
W	105	108	115	128	135	129	121	115	114
Cu – t	114	116	128	128	145	141	158	121	114
Zn – t	111	128	137	141	148	160	140	160	122
Cd – t	127	127	129	135	160	141	161	129	127
Mixed Metallic	124	131	143	152	168	161	170	131	124

Table 3: Effect of wild Cu – t , Zn – t , Cd – t strains of Glomus fasciculatum , Nostoc and chemical fertilizers on Test weight per 100 seeds (gm) of Cajanas cajan

Treatment	T	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8
W	10.50	11.2	11.60	11.50	13.89	12.89	13.06	12.40	12.90
Cu – t	11.02	11.82	11.87	12.30	13.13	12.11	13.10	12.43	12.43
Zn – t	10.82	11.52	11.48	11.84	13.40	13.60	13.59	13.36	13.30
Cd – t	10.75	11.40	11.53	12.06	13.65	12.45	13.00	13.11	13.10
Mixed Metallic	10.62	11.34	11.84	11.85	13.32	13.02	13.65	12.46	12.41

Table 4: Effect of wild Cu – t , Zn – t , Cd – t strains of Glomus fasciculatum , Nostoc and chemical fertilizers on % of root colonization of Cajanas cajan

Treatment	T	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8
W	35	37	39.4	48.5	78.4	70	64.2	61.2	52
Cu – t	35.5	41	49.7	58.8	78.4	68.4	71.4	71.4	64.2
Zn – t	36.4	48.1	59.3	68.4	76.1	86.4	80.4	80.3	63.4
Cd – t	35.3	41.3	54.2	69.4	84	80.3	80.1	80	71.4
Mixed Metallic	38.8	50.6	71.7	64.3	89.7	80.7	89.13	78.9	71.2

Table 5: Effect of wild Cu – t , Zn – t , Cd – t strains of Glomus fasciculatum , Nostoc and chemical fertilizers on number of vesicles per 100 (gm) soil of Cajanas cajan

Treatment	T	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8
W	5	7	9	12	30	14	12	16	12
Cu – t	7	9	10	11	34	24	20	10	19
Zn – t	10	16	18	25	37	44	25	12	18
Cd – t	10	16	25	27	41	39	25	34	16
Mixed Metallic	11	17	29	35	44	40	45	29	24

Table 6: Effect of wild Cu – t , Zn – t , Cd – t strains of Glomus fasciculatum , Nostoc and chemical fertilizers on number of spores of Cajanas cajan

Treatment	T	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8
W	7	10	16	18	38	28	21	18	17
Cu – t	10	12	18	17	39	24	24	10	10
Zn – t	10	14	18	21	34	40	34	31	31
Cd – t	10	17	20	28	38	31	30	28	27
Mixed Metallic	11	17	29	31	40	35	44	29	32

Effect of wild strains of Glomus fasciculatum Nostoc and chemical fertilizers on plant height, no. of pods, test weight per 100gm seeds, % of root colonization, no. of vesicles, no. of spores.

The maximum height of the plant recorded was 183.4cm at (T_4) and minimum height recorded was 158.2cm at (T) while number of pods counted maximum was 135 at (T_4) and minimum was 105 at (T). Test weight per 100 seeds 13.89 was maximum at (T_4) and 10.50 at (T). 78.4% of root colonization was maximum at (T_4) and 35 was at (T). Number of vesicles per 100gm soil was maximum up to 30 (T_4) and minimum was 5 at (T). No. of spores recorded was maximum 38 at (T_4) and minimum 7 at (T).

Effect of Cu-t strains of Glomus fasciculatum, Nostoc and chemical fertilizers on plant height, no. of pods, test weight per 100gm seeds, % of root colonization, no. of vesicles, no. of spores.

The maximum height of the plant recorded was 183.4cm at (T4) and (T6) and minimum height recorded was 158.4cm at (T), while number of pods was maximum at 158 at (T6) and minimum 114 at (T & T8). Test weight per 100 seeds was maximum 13.13 at (T4) and minimum 11.02 at (T). 78.4% of root colonization was maximum at (T4) and 35.5% minimum at (T). Number of vesicles per 100gm soil was maximum at 34 at (T4) and minimum 7 at (T).No. of spores recorded was maximum 39 at (T_4) and minimum 10 at (T,T_7,& T_8)

Effect of Zn-t strains of Glomus fasciculatum, Nostoc and chemical fertilizers on plant height, no. of pods, test weight per 100gm seeds, % of root colonization, no. of vesicles, no. of spores.

The maximum height of the plant was recorded 190.9 at (T_5) and minimum height was at 160.2 at (T) while number of pods was maximum at (T_5 & T_7) i.e 160 and minimum 111 at (T). Test weight per 100 seeds was maximum 13.60 at (T_5) and minimum 10.82 at (T). % of root colonization 86.4% was maximum at (T_5) and minimum 36.4 was recorded at (T). No. of vesicles per 100gm soil was maximum 44 at (T_5) and minimum 10 at (T). No. of spores recorded was maximum 40 at (T_5) and minimum 10 at (T).

Effect of Cd-t strains of Glomus fasciculatum, Nostoc and chemical fertilizers on plant height, no. of pods, test weight per 100gm seeds, % of root colonization, no. of vesicles, no. of spores.

The maximum height of the plant recorded was 176.9cm at (T_4) and 160.6cm minimum at (T), while number of pods counted maximum was 161 at (T_6) and minimum pods recorded was 127 at (T,T_1,T_8). Test weight per 100 seeds maximum 13.65 at (T_4) and minimum 10.75 at (T). 84% of root colonization was maximum at (T_4) and minimum 35.3 % at (T). Number of vesicles per 100gm soil was maximum 41 at (T_4) and minimum 10 at (T). Number of spores recorded was maximum 38 at (T_4) and minimum 10 at (T).

Effect of Mixed metallic (i.e Cu-t, Zn-t, and Cd-t) strains of Glomus fasciculatum, Nostoc and chemical fertilizers on plant height, no. of pods, test weight per 100gm seeds, % of root colonization, no. of vesicles, no. of spores.

The maximum height of the plant recorded was 178.9cm at (T_6) and 163.2cm at (T), while number of pods counted maximum was 170 at (T_6) and minimum pods recorded was 124 at (T & T_8). Test weight per 100 seeds maximum 13.65 at (T_6) and minimum 10.62 at (T). 89.13% of root colonization was maximum at (T_6) and 38.8% at (T). Number of vesicles per 100gm soil was 45 at (T_6) and minimum 11 at (T). Number of spores recorded was maximum 44 at (T_6) and minimum 11 at (T).

4. Discussion

Prounced growth was recorded in dual application of mycorrhizal and cyanobacterial biofertilizers. Nodule number, dry weight of root and shoot of legumes of *Cajanas cajan*, *Vigna unguiculata* was enhanced by inoculation of live yeast (*Saccharomyces cerevisiae)* and *Glomus* reported by Anjana kapoor and S.S.Wange (1989). The mean increase in grain yields than control due to inoculation along with 15 and 30 Kg N/ha. (Singh et al, 1998). Our data indicates maximum and improved results were observed due to application of all mycorrhizal and cyanobacterial biofertilizers along with chemical fertilizers.

The effect of tolerated Cu, Cd, Zn strains of *Glomus* and tolerant strains of *Nostoc* along with 10 Kg N/ha and 20 Kg P/ha of chemical fertilizers showed increased results.

Various workers (Chezhiyan et al 1999, Rabie et al 2005) have used *Glomus* and N-fixing bacteria as single inoculants and in combination with each other in various plants. The beneficial effects of phosphorus was also reflected on the increase in number of branches per plant at 60 Kg P_2O_5/ha and decrease with 90 Kg P_2O_5/ha (Shrivastava and Verma 1986) The present study demonstrated that the dual inoculation along with chemical fertilizers of *Cajanas cajan* plant increased height of plant, number of pods, test weight, % of root colonization, number of vesicles, spores to different level over single inoculation with *Glomus* or *Nostoc* alone. The present result suggest that to find the dual inoculation along with chemical fertilizer is more competitive than single inoculation and better for crop production, because both the *Nostoc paludosum* and *Glomus fasciculatum* have the capacity to absorb much of heavy metal and still by absorbing such heavy metals it shows better growth and hence it shows promising results.

5. Conclusion

Over all results confirm that chemical fertilizers can be supplemented with the addition of mycorrhizal and cyanobacterial biofertilizers to some extent. However these biofertilizers cannot totally replace the chemical fertilizers. Further, it is concluded from the experiment that the biofertilizers, a cheaper supplement to the expensive chemical fertilizers can be used in crop cultivation to reduce the use of chemical fertilizers and thus saving 50% cost of chemical fertilizers.

6. Future Outlook

Much has yet to be learned about various aspects of natural symbioses and mutalistic relation between the mycorrhiza and cyanobacterial interactions, host responses and sensing signalling between the partners. However, from the information available so far a promising approach can be made to create associations between crop plants and mycorrhiza with N_2 fixing cyanobacteria, particularly Nostoc to improve the N economy of crops by means of biological N_2 fixation. All biochemical and developmental requirements of N_2 fixation are extent within the cyanobacterial cells.

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