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G.B. PANT UNIVERSITY OF AGRIC. & TECH., PANTNAGAR (UTTARAKHAND)

PROGRESS REPORTof 2nd CROP SEASON
(*kharif* 2020 Urdbean)

Title of scheme: Impact of Nano fertilizers, biofertilizers and sea weed extracts on crop yields and soil health

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Introduction

Undoubtedly, Chemical fertilizers played key role in increasing the food grain production in the country. However, large-scale use of chemical fertilizers in imbalanced manner has brought in its wake many soil fertility problems. This stressed the need for the search of alternative and environment friendly sources of plant nutrients for obtaining higher yields in sustainable manner. In recent years, natural seaweeds, macroscopic marine algae are being used as substitute of synthetic fertilizers/bio-stimulants being contain multiple growth regulators such as cytokinins, auxins gibberellins and various macro and micronutrients necessary for plant growth and development. The seaweed extracts have also been reported in promoting the growth of beneficial soil microorganisms, developing tolerance to environmental stress, and increasing nutrient uptake from soil. Different formulations of seaweed such as liquid, granular and powder are available for foliar and soil application. Application of all these formulations of sea weed have been reported to produce beneficial effects on cereals, pulses, and many flowering plant to varying extant depending upon the doses, frequency of application and soil and environmental conditions.

Biofertilizers are live preparations of microorganisms, alone or in combination, which help in increasing the crop productivity by helping in biological nitrogen fixation, solublization of insoluble plant nutrients, stimulating plant growth or decomposition of plant residues. They improve soil health directly or indirectly through several

mechanisms. Being natural products, they do not leave any harmful effect on soil and environment. Application of N_2 fixing and phosphate solubilizing liquid and carrier based biofertilizers shown advantages in many field crops. Recently, use of consortia biofertilizer containing microorganisms for supplying NPK and micronutrients are being advocated to harness the maximum benefits of their use in crop production.

Keeping the above facts in view, a study was undertaken to assess the effect of various organic resources (Sagarika seaweed liquid and granules and liquid biofertilizer consortia) and inorganic plant nutrients on the productivity of urdbean (*Vigna mungo* L.) and succeeding wheat (*Triticum aestivum* L.) crop and soil health.

Methodology

A field experiment was conducted during *kharif* season of 2020 at Norman E. Borlaug Crop Research Center (NEBCRC) of the University (29.8° N, 73.9° E, 243.8 m above mean sea level) to assess the effect of seaweed liquid, seaweed granules, liquid biofertilizers consortia and chemical fertilizers in urdbean on the productivity and soil health. The experimental soil was Sandy loam of pH 7.3, EC 0.32 dS m^{-1}, Organic C 0.72% and available N, P and K of 148.3, 22.3 and 185.7 kg/ha, respectively. Ten treatments comprising different combinations of liquid biofertilizers consortia, seaweed liquid, seaweed granules and chemical fertilizers were laid out in randomized block design in 3 replication in plots of 4m x 5m. Urdbean (cv. Pant Urd 31) was sown on 04/08/2020 keeping seed rate 20 kg/ha. The Sagrika seaweed liquid and granules, liquid biofertilizer consortia and water soluble fertilizer (18:18:18) were obtained from IFFCO. The seed were treated with liquid biofertilizer consortia @ 10 ml/kg seed while Sagrika seaweed granules, was applied @ 25 kg/ha at the time of sowing as per treatment. Foliar spray of 1.0% IFFCO water-soluble fertilizer (18-18-18) and Urea (46-0-0) was done at 50 % flowering age (18/09/2020). RDF treatment was executed through basal application of 18 kg N, 48 kg P_2O_5 and 24 kg K_2O/ha^{-1} through application of 150 kg NPK mixture of 12-32-16 grade/ha. The crop was raised following recommended agronomic practices.

Root nodulation was recorded at 30 days and 45 days after sowing (DAS) from ten randomly selected plants. Plants were uprooted along with soil core of about 25 cm, the adhering soil on roots was gently washed off, root nodules were removed and counted. The dry weight of detached nodules and plants was recorded after drying in hot air oven at 70 °C to constant weight. The chlorophyll content in urdbean leaves was

estimated at 40 DAS by SPAD value using leaf chlorophyll meter (atLeaf CHL PLUS, FT Green LLC, USA). The SPAD values of ten leaves were recorded and mean value was expressed. Soil samples of 0-15 cm depth were collected from individual plots at 40 DAS, stored in refrigerator at 4^{o}C and activities of soil dehydrogenase, Urease and Acid and Alkaline phosphatase were estimated following the methods described by Page *et al*. (1982).The experimental data were statistically analyzed by applying analysis of variance and treatments were compared using the F-test by calculating the critical difference at 5% level of significance. The grain and straw yields were recorded after harvesting the crop on 18/10/2020.

Results

Root Nodulation

Application of different inorganic and organic nutrients in urdbean influenced the number and dry weight of root nodules significantly at 30 and 45 days after sowing (DAS) over the no fertilizer control (T1) (**Table 1**). Application of 50% RDF along with seed inoculation with liquid biofertilizer consortia (T4) gave 41.8 and 58.8% significantly more root nodule number and 68.8 and 68.0 % more nodule dry weight than the control at 30 and 45 days crop age, respectively. However, it was statistically comparable with 100% RDF treatment (T2) in nodule dry weight. Application of 50% RDF along with seed inoculation with liquid biofertilizer consortia + soil application of 25 kg/ha seaweed granules (T_5) produced significantly more nodule number over the 100% RDF at both the intervals. Application of other nutrients sources along with 50% RDF + liquid biofertilizer consortia [i.e. foliar spray of 1 % WSF (T_7) and Urea (T_8) at flowering, seaweed granuls+0.25 % foliar spray of seaweed liquid at 30 and 45 DAS (T_{10})] were comparable to application of 50% RDF + liquid biofertilizer consortia in number and nodule dry weight at both the intervals **(Table 1)**.

Plant dry matter

Treatments of 50% RDF along with liquid biofertilizer consortia alone (T4) and liquid biofertilizer consortia + 25 kg/ha seaweed granules (T5) at sowing were at par and gave significantly more plant dry weight at 30 and 45 DAS over the control (**Table 2**). Both these treatments were also at par with 100% RDF in plant dry weight at both the intervals. Foliar spray 0f 1% urea (T6) and 1 % WSF (T7) at flowering along with application of 50% RDF + liquid biofertilizer consortia by registering significantly more plant dry weight than

Table: 1. Effect of different inorganic and organic nutrient sources on root nodulation

Treatment		No. of Nodules/plant		Nodule dry weight (mg/plant)	
		30 DAS	45 DAS	30 DAS	45 DAS
T1	Control	22.7	19.7	9.3	15.0
T2	100 % RDF	26.1	23.1	13.3	20.3
T3	50 % RDF	27.5	25.7	13.1	15.5
T4	T3 + liquid Biofertilizer Consortia @ 10ml/kg seed	32.2	31.3	15.7	25.2
T5	T4 + Soil application 25 kg/ha seaweed granules	34.5	32.3	16.1	26.9
T6	T4 + 1% Urea foliar spray at flowering	32.7	29.3	14.4	26.9
T7	T4+ 1% WSF (18:18:18) foliar spray at flowering	31.5	29.5	14.9	26.6
T8	T5 + 1% Urea foliar spray at flowering	32.6	29.8	15.9	30.4
T9	T5 + 1% WSF (18:18:18) foliar spray at flowering	32.3	30.9	16.4	31.1
T10	T5 + Foliar spray 0.25% seaweed liquid at 30 and 45 DAS	32.7	32.3	16.5	33.6
S.Em.±		2.1	2.3	1.4	3.1
C.D. at 5%		6.3	6.9	4.2	9.3

the control were also statistically comparable with T4 in plant dry weight at both the intervals. Treatments of 50% RDF + liquid biofertilizer consortia + 25 kg/ha seaweed granules together with foliar spray of 1% Urea (T8) or 1% WSF (T9) or 2 foliar spray of 0.25 % seaweed liquid (T10) were also statistically comparable with T4. The effect of different nutrient sources was not much evident on plant dry weight at 30 DAS. However, all organic nutrient sources in combination of 50% RDF recorded significantly more plant dry weight than 50% RDF alone and comparable to 100% RDF alone application. Treatment T10 (50% RDF + liquid biofertilizer consortia + 25 kg/ha seaweed granules+ 2 foliar spray of 0.25 % seaweed liquid at 30 and 45 DAS) recorded significantly more plant dry weight than 100% RDF at 45 DAS. The different treatments did not varied significantly in chlorophyll content at 40 DAS.

Table: 2. Effect of different inorganic and organic nutrient sources on plant dry weight and chlorophyll content

Treatment		Plant dry weight (g/plant)		Chorophyll (SPAD value) at 40 DAS
		30 DAS	45 DAS	
T1	Control	1.33	6.65	46.07
T2	100 % RDF	2.04	8.06	49.45
T3	50 % RDF	1.99	7.03	48.19
T4	T3 + liquid Biofertilizer Consortia @ 10ml/kg seed	2.03	11.32	48.80
T5	T4 + Soil application 25 kg/ha seaweed granules	2.05	12.46	49.37
T6	T4 + 1% Urea foliar spray at flowering	2.22	11.20	47.81
T7	T4+ 1% WSF (18:18:18) foliar spray at flowering	2.02	11.62	47.21
T8	T5 + 1% Urea foliar spray at flowering	2.03	12.38	47.97
T9	T5 + 1% WSF (18:18:18) foliar spray at flowering	2.10	12.39	47.72
T10	T5 + Foliar spray 0.25% seaweed liquid at 30 and 45 DAS	2.26	12.86	49.45
S.Em.±		0.16	1.19	1.06
C.D. at 5%		0.46	3.55	NS

Grain and straw yield

Application of different nutrients sources in urdbean influenced the grain yield significantly (**Table 3**). Application of 100% RDF (T2) and 50% RDF + NPK consortia biofertilizer (T4) were at par and gave significantly more grain yield of 18.6 % over the control and 15.0 % over 50% RDF alone application (T3). An additional use of 25 kg/ha seaweed granules with 50% RDF + NPK consortia biofertilizer (T5) was also statistically comparable to T2 and T4 in grain yield. Foliar spray of 1% Urea or 1 % WSF with 50% RDF + liquid biofertilizer consortia + 25 kg/ha seaweed granules (T8 and T9) were at par with T4 by producing numerically 5.3 and 2.5% more grain yield. The highest grain yield was obtained with T10 (50% RDF + liquid biofertilizer consortia + 25 kg/ha seaweed granules+ 2 foliar spray of 0.25 % seaweed liquid at 30 and 45 DAS), which was significantly higher, by 13.9% over 100 % RDF and, by 13.8% over 50% RDF + liquid

biofertilizer consortia (Table 2).

Although statistically significant variations were not recorded in straw yield and weight of 1000 grains due to different treatments, nevertheless, application of 100% RDF (T2) and 50% RDF + liquid biofertilizer consortia + 25 kg/ha seaweed granules + 2 foliar spray of 0.25 % seaweed liquid at 30 and 45 DAS (T10) recorded 25.8 and 24.1 % numerically higher straw yield over control and 10.0 and 8.4 % over 50% RDF alone, respectively.

Table: 3. Effect of different inorganic and organic nutrient sources on yield

Treatment		**Grain Yield (kg/ha)**	**Straw Yield (kg/ha)**	**Thousand grain weight (g)**
T1	Control	1071	1542	35.14
T2	100 % RDF	1270	1941	35.63
T3	50 % RDF	1104	1764	35.37
T4	T3 + liquid Biofertilizer Consortia @ 10ml/kg seed	1271	1852	35.66
T5	T4 + Soil application 25 kg/ha seaweed granules	1292	1919	35.83
T6	T4 + 1% Urea foliar spray at flowering	1321	1934	35.68
T7	T4+ 1% WSF (18:18:18) foliar spray at flowering	1297	1806	35.39
T8	T5 + 1% Urea foliar spray at flowering	1329	1941	35.12
T9	T5 + 1% WSF (18:18:18) foliar spray at flowering	1304	1931	35.86
T10	T5 + Foliar spray 0.25% seaweed liquid at 30 and 45 DAS	1447	1913	35.46
	S.Em.±	54.51	94.57	1.11
	C.D. at 5%	161.94	NS	NS

Soil enzymes

Different treatments influenced the activities of soil dehydrogenase, urease and phosphatase significantly at 40 DAS. Application of 50 and 100 % RDF was at par (**Table 4**), while 100% RDF recorded more soil dehydrogenase activity than the control. Seed inoculation with liquid biofertilizer consortia with 50% RDF (T4) as well as 50% RDF with all other nutrients sources (i.e. seaweed granules or foliar spray of urea/WSF/ seaweed liquid) were at par and gave significantly higher soil dehydrogenase activity than the

control (T1) and 50% RDF (T3). All nutrient treatments gave significantly more soil urease activity than the control. Application of 50% RDF along with seed inoculation with liquid biofertilizer consortia (T4) by registering significantly more urease activity than 50% RDF, was at par with 100% RDF and all other nutrients sources (i.e. 50% RDF + seaweed granules/ foliar spray of urea/WSF/ seaweed extract). The highest dehydrogenase and urease activity was registered with T10.

Table: 4. Effect of different inorganic and organic nutrient sources on soil enzyme activities at 40 DAS

Treatment		Dehydrogenase (µg TPF/g soil/day)	Urease (µg urea/g soil/h)	Phosphatase (µg PNP/g soil/h)	
				Acidic	Alkaline
T1	Control	137.5	17.7	75.5	71.5
T2	100 % RDF	159.4	31.2	88.6	83.9
T3	50 % RDF	140.1	21.3	79.3	78.9
T4	T3 + liquid Biofertilizer Consortia @ 10ml/kg seed	162.9	31.7	110.3	97.6
T5	T4 + Soil application 25 kg/ha seaweed granules	172.3	32.6	117.1	104.6
T6	T4 + 1% Urea foliar spray at flowering	164.7	32.0	107.4	95.4
T7	T4+ 1% WSF (18:18:18) foliar spray at flowering	161.7	30.7	109.4	99.1
T8	T5 + 1% Urea foliar spray at flowering	173.8	32.7	115.6	102.2
T9	T5 + 1% WSF (18:18:18) foliar spray at flowering	175.2	32.1	114.9	107.6
T10	T5 + Foliar spray 0.25% seaweed liquid at 30 and 45 DAS	174.2	33.3	115.5	108.8
S.Em.±		7.4	2.7	6.8	7.9
C.D. at 5%		22.0	8.1	20.3	23.5

All the treatments, except 50 and 100% RDF, recorded significantly more acid and alkaline phosphatase activities in soil than the control. The different treatments of 50% RDF with liquid biofertilizer consortia, alone or with other nutrients sources, were at par in acid and alkaline phosphatase activities. The highest acid and alkaline phosphatase activities were noticed with 50% RDF + liquid biofertilizer consortia + seaweed granules +

2-foliar spray of 0.25% seaweed liquid (T10). It gave significantly more alkaline phosphatase activity than T4.

Conclusion

Results revealed that application of 50 % RDF and seed inoculation with liquid biofertilizer consortia in urdbean gave grain yield similar to application of 100% RDF. Application 25 kg/ha seaweed granules and 2 foliar spary of 0.25 % seaweed liquid at 30 and 45 DAS in combination with 50% RDF+ liquid biofertilizer consortia further increased the grain yield over 50% RDF + liquid biofertilizer consortia treatment.

Foliar spary of Urea and WSF at 45 DAS

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