Study 2.

Nutrient optimisation through organic & inorganic resources in urdbean-wheat cropping sequence

Introduction

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 is associated with 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

Residual effect of treatments comprising different combinations of liquid biofertilizer consortia, seaweed liquid, seaweed granules and chemical fertilizers in urdbean during kharif 2020 was assessed on succeeding wheat in field experiment during *Rabi* season of 2020-21 at Norman E. Borlaug Crop Research Center of the University. The experimental soil was Sandy loam having 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, at the time of initiation of the study on urdbean. Ten treatments, as per details given in table 1, were executed in randomized block design in 3 replications in plots of 4m x 5m. Wheat (cv. PBW 502) was sown on 19/11/2020 keeping seed rate 100 kg/ha. The Sagrika seaweed liquid and granules, liquid biofertilizer consortia 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. The 100 % RDF (120:60:40 N, P_2O_5, K_2O kg/ha) and 75 % RDF treatments were executed through application of NPK mixture of 12-32-16 grade and Urea as per treatments. Nitrogen was applied in 3 equal splits and full doses of P and K at sowing. The crop was raised following recommended agronomic practices. The crop was harvested on 16 April 2021.

Five plants of wheat were cut above soil surface from each plot at 40 and 75 DAS and their dry weight was recorded. The height of the 5-tagged plants was measured with meter scale at intervals of 40 and 75 DAS and at maturity. The chlorophyll content in leaves was estimated at 75 DAS as SPAD value using leaf chlorophyll meter (at Leaf CHL PLUS, FT Green LLC, USA). The SPAD values of ten leaves were recorded and mean value was expressed. Number of total tillers were recorded at 75 DAS and maturity and effective tillers at maturity. The grain and straw yields were recorded after harvesting. Soil samples of 0-15 cm depth were collected from individual plots at 75 DAS, stored in refrigerator at 4ºC 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.

Table 1. Treatment detail during urdbean-wheat sequence

	Treatment in Urdbean	**Treatment in succeeding wheat**
T1	Control	100% RDF
T2	100 % RDF	100% RDF
T3	50 % RDF	75% NPK with Biofertilizer Consortia +25 kg sea weed Granules + 2- foliar spray of 0.25 % sea weed Liquid at 30 & 45 DAS
T4	T3 + liquid Biofertilizer Consortia @ 10ml/kg seed	-do-
T5	T4 + Soil application 25 kg/ha seaweed granules	-do-
T6	T4 + 1% Urea foliar spray at flowering	-do-
T7	T4+ 1% WSF (18:18:18) foliar spray at flowering	-do-
T8	T5 + 1% Urea foliar spray at flowering	-do-
T9	T5 + 1% WSF (18:18:18) foliar spray at flowering	-do-
T10	T5 + Foliar spray 0.25% seaweed liquid at 30 and 45 DAS	-do-

Results

Plant height

Plant height of wheat due to different treatments did not differ significantly **(Table 2)**. The maximum plant height at all the intervals was recorded with treatment T9 at 40 DAS and T8 at 75 DAS and maturity. However, both these treatments gave comparable plant height at all the intervals and recorded 7.5, 10.1 and 1.3 % more plant height than T2 (100%-100% RDF in urdbean-wheat sequence). Application 50% RDF in combinations of liquid biofertilizers consortia, seaweed granules and folar spray of Urea and WSF in urdbean followed by 75% NPK in wheat with Biofertilizer Consortia +25 kg sea weed Granules + 2-spray of 0.25 % sea weed Liquid at 30 & 45 DAS (T5, T8, T9 & T10) gave slightly more plant height in comparison to T2 at different intervals (**Table 2**).

Table 2. Effect of different treatments in urdbean-wheat sequence on plant height

Treatment	Plant height (cm)			Shoot dry weight (g/plant)	
	40 DAS	75 DAS	At Maturity	40 DAS	75 DAS
T1	22.9	51.9	99.6	1.75	8.30
T2	23.8	52.7	103.3	1.75	8.48
T3	24.0	54.1	98.9	1.77	8.32
T4	22.9	54.4	95.8	1.81	8.46
T5	25.5	56.2	103.6	1.84	9.01
T6	24.5	56.4	100.6	1.81	8.43
T7	25.1	56.3	101.9	1.80	8.49
T8	25.3	58.0	104.6	1.84	9.24
T9	25.6	57.3	103.1	1.85	9.57
T10	25.3	58.4	104.1	1.85	9.08
C. D. @ 5%	**NS**	**NS**	**NS**	**NS**	**NS**
C.V. (%)	**8.69**	**10.4**	**8.9**	**9.20**	**9.58**

Shoot dry matter

The different treatments in urdbean also did not influence the shoot dry weight significantly of succeeding wheat crop at 40 and 75 DAS. The maximum shoot dry weight was recorded with treatment T9 at both 40 and 75 DAS. It gave 5.7 and 12.8 % more shoot dry matter than T2 (100% RDF in in both urdbean-wheat sequence) (**Table 2**.

Tiller number

Total and effective tillers were at par due to different treatments. The maximum total tillers at 40 DAS and maturity was recorded with T9 and effective tillers at maturity with treatment T8. However, both these treatments were comparable in tiller numbers. (**Table 3)**.

Yield and yield attributes

Wheat grain and straw yields due to different treatments in urdbean-wheat sequence were statistically at par. (**Table 4).** The highest grain and straw yields were recorded with treatment T9, registering numerical increases of 14.4 and 13.4% in grain and straw yields over T1 (0-100% RDF in urdbean-wheat sequence) and 11.0 and 5.8% over T2 (100% RDF in both urd and wheat). It was followed by treatment T8 in wheat grain and straw yields. The variations due to different treatments were also non-significant in different yield attributes i.e. ear length, number of spikelet/ear and number of grains / spikelet.

Table 3. Effect of different treatments in urdbean-wheat sequence on leaf chlorophyll content and number of total and effective tillers

Treatment	SPAD reading	Total tillers/ plant	Total tillers/ m row	Effective tillers/ m row
	(75 DAS)	(75 DAS)	At maturity	At maturity
T1	53.7	9.7	81.0	75.7
T2	54.2	10.1	82.0	76.3
T3	54.2	10.2	81.0	75.7
T4	56.3	10.4	80.7	78.7
T5	54.9	10.5	83.3	79.0
T6	55.7	10.1	84.0	78.0
T7	55.8	10.3	82.0	77.7
T8	56.4	10.5	83.0	79.7
T9	56.4	10.5	83.3	79.3
T10	56.5	10.4	83.0	79.7
C. D. @ 5%	**NS**	**NS**	**NS**	**NS**
C.V. (%)	**7.8**	**11.5**	**15.9**	**19.2**

Soil biological health

Microbial biomass C in soil estimated at 75 DAS was highest with T9, being 10.0 % more over T2 and was at par with all other treatments in urdbean-wheat sequence (**Table 5**). The maximum dehydrogenase and Urease activities in soil were recorded with T8, which was 31.5 and 9.7 % higher over T2. and comparable with T9. The latter treatment recorded maximum acid and alkaline phosphatase activities in soil, being 6.3 6.2 % more than T2, respectively.

Table 4. Effect of different treatments in urdbean-wheat sequence on yield and yield attributes

Treatment	Yield (q/ha)		Yield attributes		
	Grain	Straw	Ear length (cm)	No. of spikelet/panicle	No. of grains/ear
T1	39.26	60.33	10.5	17.3	45.7
T2	40.47	64.69	11.4	17.7	46.3
T3	40.70	65.29	11.4	17.9	48.7
T4	43.04	65.86	11.3	18.3	48.5
T5	44.68	67.09	11.3	18.2	48.5
T6	42.72	65.20	11.1	17.9	48.4
T7	43.23	65.47	11.4	17.5	47.9
T8	44.71	67.48	11.6	18.1	48.5
T9	44.93	68.45	11.4	18.7	48.6
T10	44.07	66.50	11.3	18.0	48.9
C. D. @ 5%	**NS**	**NS**	**NS**	**NS**	**NS**
C.V. (%)	**9.69**	**11.82**	**8.1**	**8.6**	**10.3**

Conclusion

Results revealed that treatments comprising different combinations of liquid biofertilizer consortia, seaweed liquid, seaweed granules and chemical fertilizers in urdbean did not show significant residual effect on growth and yield of succeeding wheat. However, treatments receiving seaweed granules in urdbean showed slight benefits on the yield of succeeding wheat and soil biological health.

Table 4. Effect of different treatments in urdbean-wheat sequence on soil enzyme activities at 75 DAS

Treatment	MBC (ug/g soil)	DHA (µg TPF/g soil/day)	Urease activity (µg urea/ g soil /h)	phosphatase (µg PNP/g soil/ h)	
				Acid	Alklaine
T1	306.8	101.9	21.6	58.2	74.8
T2	344.5	104.2	22.4	62.1	76.1
T3	362.5	106.4	21.5	63.5	73.2
T4	352.7	122.8	19.6	62.9	78.4
T5	374.2	132.4	25.6	65.6	79.8
T6	366.3	121.6	26.1	61.4	77.3
T7	365.4	110.7	23.7	62.2	79.1
T8	375.1	137.0	24.6	65.1	79.5
T9	379.2	136.1	24.1	66.9	80.80
T10	385.5	132.1	24.5	66.3	79.5
C. D. @ 5%	**NS**	**NS**	**NS**	**NS**	**NS**
C.V. (%)	**12.2**	**13.9**	**15.8**	**13.6**	**14.3**

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Crop in field at 40 DAS


Spray on Sea weed extracts


T2- 100% RDF
T1- 100% RDF


T5- 75% RDF +
BF + SG +
SE-2FS


T4- 75% RDF +
BF + SG +
SE-2FS


T8- 75% RDF +
BF + SG +
SE-2FS


T9- 75% RDF +
BF + SG +
SE-2FS


T10- 75% RDF
+ BF + SG
+ SE-2FS