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EFFECTS OF UREA SUPER GRANULE (USG) ON THE LIMNOLOGICAL PARAMETERS OF POND AND FISH PRODUCTION

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Abstract

The efficacy of urea super granule (USG) was found out comparing its effects on pond productivity and fish production with that of normal granular urea. There were two treatments with two replicates of each. Treatment 1 was designed with fortnightly application of USG (50 kg/ha), TSP (25 kg/ha) and cow dung (1000 kg/ha) while treatment 2 was designed with fortnightly application of normal granular urea (50 kg/ha), TSP (25 kg/ha) and cow dung (1000 kg/ha). The ponds were stocked with seven carp species with a stocking density of 40 fingerlings/decimal. Variation in water and soil quality parameters, plankton population and gross production of fish were used to compare the effectiveness of the two types of urea. Although most of the water quality parameters were within the acceptable range for fish culture in both the treatments but dissolved oxygen, nitrate-nitrogen and phosphate-phosphorus were significantly higher ($P<0.05$) in treatment 1 where USG was used. Quantitatively, plankton population was significantly higher ($P<0.05$) in treatment 1. There was no significant variation ($P>0.05$) between the treatments regarding soil quality parameters and gross production of fish but the economic analysis revealed a relatively higher net profit in treatment 1.

Key words: Urea super granule, fish production

Introduction

The fisheries resources play a very significant role in Bangladesh economy. Fish contributes about 58% of the nation's animal protein intake, nearly 3.74% of the GDP which is about 22.23% of the agricultural and 2.70% of the total export earning of the country. This sector provides full time/part-time employment for about 14.5 million people or about 10% of the active population of the country (DOF 2011).

Bangladesh has vast fishery potential within her boundaries in the form of innumerable rivers, canals, haors, baors, beels, ponds, tanks and vast coastal belt. From these sources Bangladesh gets about 2.89 million MT of fish every year, most of which are from capture fishery. But in recent years due to environmental pollution, over fishing and indiscriminate killing of fish etc. total percentage contributed by capture fishery is decreasing. At the same time marine fishery resources are being exploited indiscriminately. For these reasons, culture fishery has become the main potential source of aquaculture development.

Culture of fish in pond depends on several factors. According to Manjunathan and Shetty (1991), successful pond fish culture operations primarily depend on the maintenance of a healthy aquatic environment and the production of sufficient fish food organisms. Carps primarily feed on plankton and growth of plankton is enhanced by the availability of inorganic nutrients such as nitrogen, phosphorus, potassium etc. in water as well as in soil. But the amount of essential inorganic nutrients which are already present in the soil and water may not be sufficient for the growth of expected amount of fish food, i.e., plankton which are necessary for maximum growth of fish. In such cases, inorganic as well as organic fertilizers are applied in the ponds to increase primarily the phytoplankton and finally the fish production.

Fish pond fertilization as a management tool in culture practices has a long history in Europe and goes back to ancient China (Zhu *et al.*, 1990). Both organic and inorganic fertilizers are used in pond fish culture with the purpose to supplement essential nutrients to augment the growth of fish food organisms. Urea is an inorganic nitrogenous fertilizer widely used in agricultural lands or aquaculture ponds. It is normally used in small granular forms. Use of this fertilizer in super granule form commonly known as Urea Super Granules (USG) is a new introduction to increase certain agricultural crops particularly boro paddy. Available information suggests that compared to normal granular urea, USG has certain advantages. If used properly, it dissolves slowly, its wastage through dissipation in gaseous form is much less and its utilization by the plants is more. All these benefits combine to account for higher production of crops and greater economic benefits for the farmers (ATDP, 1998). No published reports are available on its use in aquaculture ponds. Considering the benefits of USG in agricultural lands, an attempt was taken on farm trial to find out the effectiveness of USG in aquaculture.

The objectives of the proposed study were, however, to find out the effectiveness of USG comparing its efficacy with that of normal urea on the followings:

i) Limnological parameters of soil and water of pond.
ii) Enhancement of primary and secondary productivity in the pond water.
iii) Growth and production of fish.
iv) Economics of fish production.

Material and Method

The experiment was carried out in four ponds in Panna Bohumukhi Krishi Khamar (PBKK) located in village-Balughata, Thana-Nalitabari. District-Sherpur. All the ponds were rectangular in shape, situated around the farm. house and varied from 40-80 decimal in size. The experimental ponds were arbitrarily numbered as P_1, P_2, P_3 and P_4 for recording data and reporting the result properly. The experiment was planned in Randomized Block Design. There were two treatments with two replicates of each. Treatment 1 was designed with fortnightly application of USG (50 kg/ha), TSP (25 kg/ha) and cow dung (1000 kg/ha) while treatment 2 was designed with fortnightly application of normal granular urea (50 kg/ha), TSP (25 kg/ha) and cow dung (1000 kg/ha). The ponds were stocked with silver carp (*Hypophthalmicthys molitrix*), catla (*Catla catla*), rohu (*Labeo rohila*), mrigal (*Cirrhinus mrigala*), common carp (*Cyprinus carpio*), grass carp (*Ctenopharyngodon idella*) and Thai sharpunti (*Barbodes gonionotus*). The stocking density was 40 fingerlings/decimal (silver carp 12, catla 5, Rohu 6, Mrigal 3, Common Carp 3, Grass carp 3 and Thai sharpunti 8).

Before starting the experiment, the ponds were thoroughly prepared. Firstly, the ponds were dried, bottom re-excavated and the banks of the ponds were reconstructed. Then lime with a dose of 1 kg/decimal was applied in the ponds. Seven days after liming, cow dung at the rate of 2.47 MT/hectare was applied in the experimental ponds and kept the ponds exposed to the air./// awaited for rain. Upon filling the ponds with rain water, inorganic fertilizers were applied according to the experimental design. After a week of fertilization, the ponds were ready for stocking of fish.

The mode of application of USG and normal urea was important for this experiment. USG is normally applied in the agricultural fields by inserting the granules at a depth of 7-10 cm in the soil at regular intervals, but in aquaculture, this practice is not suitable because nitrogen needs to be available in water for augmentation of plankton growth. Therefore, in the present study in treatment 1, USG were applied by hanging on cloth at a depth of 30 cm from the water surface of the ponds by attaching it on bamboo poles at a regular intervals. Each 250g USG packed in synthetic mosquito nets when hung in the manner as described above needed 20-30 minutes to dissolve. In treatment 2, normal urea was applied by dissolving in water and then sprinkling it over the whole water area. The basic difference is that in Treatment 1, nitrogen from urea dissolve in water slowly and thus ensured less loss through evaporation while in treatment 2, the scenario was completely reverse.

After stocking of fish the ponds were regularly fertilized in accordance with the experimental design. Supplementary feed composed of rice bran (60%), mustard oil cake (30%) and dried crushed fish (10%) was applied at the rate of 3% body weight of the existing fish stock. Besides, soft grass same to the body weight of the existing grass carp and Thai sharpunti was supplied in the ponds. The feeding rate was adjusted monthly after sampling of fish. Temperature, transparency, pH and dissolved oxygen were measured at fortnightly intervals and nitrate-nitrogen, nitrite-nitrogen and phosphate-phosphorous were measured at monthly intervals in tills experiment. Temperature, transparency and pH were measured on the spot by a Celsius thermometer, a standard secchi disc (25 cm diameter) and pH paper (Merck, Germany) respectively. For dissolved oxygen, water samples from the ponds were collected in black bottles, preserved with toluene and measured in the BAU laboratory by a digital DO meter (YSI model 58). A Hach Kit (DR/2000, Direct reading, Spectrophotometer) was used to analyze nitrate, nitrite- nitrogen and phosphate-phosphorous content in water samples.

Plankton samples were collected at fortnightly intervals from the experimental ponds. A tube sampler described by Stirling (1985) was used for plankton sample collection. Both quantitative and qualitative study of plankton (phytoplankton and zooplankton) were made by using a Sedge-wick Rafter cell (SR cell) and a binocular microscope (Olympus model BH-2 with phase contrast facilities) following the procedure of Pennak (1953), Ward and Whipple (1959) and Prescott (1962).

Soil quality parameters were analyzed twice- firstly, before initial fertilization and secondly, after closing the experiment. Both physical and chemical parameters of soil viz. soil texture, pH, organic carbon, total nitrogen, nitrate-nitrogen, ammonia-nitrogen, available phosphorous and sulfur and exchangeable potassium were analyzed in the BAU Humboldt Soil Testing Laboratory following the methods of Hunter (1984), Jackson (1962), *Olsen et a!.* (1954) and Page *et at.* (1982).

Sampling of fish was done on the 30th of every month. Partial harvesting of silver carp in both the treatments were done after three months of stocking. Fishes of all ponds were completely harvested after six months of rearing, first by seine net and then by draining out of the ponds. At the time of harvest, all fishes were counted and weighed individually for each pond to assess the survival rate and production.

The growth performance of experimental fishes in different treatments was measured by using the following formula:

$$\text{SGR (\% per day)} = \frac{\text{In } W_2 - \text{ In } W_1}{T_2 - T_1} \times 100$$

Where

W_1 = Mean initial fish weight (g) at the time of T_1 (day)

W_2= Mean final fish weight (g) at the time of T_2 (day)

Results and Discussion

Water quality parameters

Summary of data on various water quality parameters are presented in Table 1. Temperature was more or less similar in both the treatments. The highest water temperature during the experiment was recorded to be 32.7°C in the month of August and the lowest of the same was found in October. Transparency (secchi reading) was always lower in USG treated ponds than normal urea treated ponds during the entire study period. The average pH values were always above 7 and ranged between 6.95 and 8.25 in USG treated treatment and 6.64 and 8.0 in normal urea treated treatment. Dissolved oxygen content was significantly higher ($P<0.05$) in USG treated ponds and ranged between 4.83 and 8.14 ppm in treatment 1 and 3.95 and 7.17 ppm in treatment 2. Nitrate-nitrogen content was also significantly higher ($P<0.05$) in treatment 1 receiving USG than treatment 2 receiving normal urea and the values were 1.6 to 3.0 ppm in treatment 1 and 1.4 to 2.1.ppm in treatment 2. There was no significant variation ($P>0.05$) in the nitrate-nitrogen content of pond water

Table 1: Comparison of water quality parameters (Mean±SD) with ranges between treatment 1 and treatment 2 by using ANOVA.

Parameters	**Treatment 1**	**Treatment 2**	**F- value**
Temperature (°C)	30.89±0.87 (28.9 - 32.6)	30.91 ± 0.83 (28.9 - 32.7)	0.002^{NS}
Transparency (cm)	28.86 ± 1.44 (25.2-31.7)	31.00 ±3.76 (14.4-36.4)	3.393^{NS}
p^H	7.45 ±0.28 (6.95-8.25)	7.35 ±0.28 (6.64-8.0)	0.776^{NS}
Dissolved oxygen (ppm)	6.19 ±0.71 (4.83-8.14)	5.34 ± 0.76 (3.95-7.17)	8.009**
NO_3-N (ppm)	2.13±0.45 (1.6-3.0)	1.71 ±0.22 (1.4-2.1)	8.715**
NO_2-N (ppm)	0.031 ± 0.02 (0.009-0.054)	0.037 ± 0.02 (0.009-0.076)	0.0534^{NS}
PO_4-P (ppm)	1.005 ±0.65 (0.21-1,96)	0.523 ± 0.32 (0.19-1.18)	5.254*

^{NS} indicates non significant (P>0.05)
* indicates significant (P<0.05)
** indicates significant (P<0.01)

receiving USG and normal urea. Like nitrate, phosphate-phosphorus content was also significantly higher (P<0.05) in USG receiving treatment than normal urea and the values ranged from 0.21 to 1.96 in treatment 1 and 0.19 to 1.18 in treatment 2.

For warm water fishes, DOF (1996) reported the suitable range of temperature from 25 wto 35°C, pH from 6.4 to 8.0 and dissolved oxygen from 5 to 8 ppm. Alikunhi (1957) stated that a good pond water for fish culture should have dissolved oxygen range of 5 to 7 ppm, phosphate 0.2 to 0.4 ppm and nitrate 0.06 to 1.0 ppm. Boyd (1982) suggested that a transparency between 15 and 40 cm is good for fish culture. The water quality parameters during this experiment were within the favourable range in accordance to the above findings.

Plankton population in pond Water

Six planktonic groups consisting of 48 genera were identified from different pond water throughout the study period. Apart from some rarely occurring individuals, the total planktonic organisms mainly consisted of 4 groups of phytoplankton and 2 groups of zooplankton. Some 37 genera of phytoplankton belonging to Bacillariophyceae (5), Chlorophyceae (21), Cyanophyceac (8) and Euglenophyceae (3) were found. The dominant phytoplankton genera identified were *Ankistrodesmus, Chlorella, Closterium, Cyclotella, Euglena, Fragillaria, Gonatozygon, Merismorphodia. Navicula, Oscillatoria, Pediastrum, Scenedesmus, Spirogyra and Ulothrix.* Eleven genera of zooplankton were also identified which belonged to Crustacea (4) and Rotifera (7). Among zooplankton the dominant genera were *Asplanchna, Brachionus, Cyclops, Diaptomus, Keratella,* Nauplius and *Polyarthra.* Quantitatively, plankton population was signifcantly higher (P<0,05) in USG

Table 2: Mean (±SD) plankton number (x 104 cells/L) and comparison of different groups of plankton between two treatments using ANOVA.

Plankton group	**Treatment 1**	**Treatment 2**	**F- value**
Phytoplankton			
Bacillariophyccae	19.56 ±05.19	15.26 ±04.03	5.149*
Chlorophyceae	97.53 ± 16.47	64.44 ± 15.81	23.827**
Cyanophyceae.	24.03 ± 12.54	19.91 ± 10.55	0.759^{NS}
Euglenophyceae	10.61 ± 02.89	8.77 ± 02.59	2.697
Total phytoplankton	151.73 ±32.62	108.38 ± 22.78	14.239**
Zooplankton			
Crustacea	5.61 ± 01.22	4.74 ±00.84	4.238^{NS}
Rotifera	8.25 ±01.33	5.88 ±01.05	23.39**
Total zooplankton	13.86 ±02.24	10.62 ±01.59	16.829**
Total plankton	165.59 ±34.47	119.00 ±24.06	14.742**

^{NS} indicates non significant (P>0.05).

* indicates significant (P<0.05).

** indicates significant (P<0.01).

treated ponds, may be due to the slow dissolving of nitrogen in water and less wastage. The overall mean values of plankton with their different groups have been shown in Table 2 and the monthly variations of total phytoplankton and zooplankton are shown in Figures 2 and 3 respectively.

In quantitative study, total phytoplankton ranged from 118.41 to 197.53 x 10^4 cells/L and 86.32 x 10^4 to 144.26x10^4 cells/L and the mean values were 151.73±32.62x10^4 cells/L and 108.38±22.78x10^4 cells/L in T_1 and T_2 respectively. Zooplankton concentration was found to vary from 11.59 to 17.37x104 cells/L and 8.95 to 13.16 x 10^4 cells/L in T_1 and T_2 respectively. Wahab *et al.* (1994) recorded phytoplankton numbers ranging from 20.0x10^4 cells/L to 80.0x10^4 cells/L and zooplankton between 2.0x 10^4 cells/L and 20.0x 10^4 cells/L. Haque *et al.* (1998) found phytoplankton to vary from 10.7 to 50.56x10^4 cells/L and zooplankton from 4.9 to 6.16x104 cells/L. The quantitative value of plankton in this study was quite higher than the above findings. Forthnightly application of inorganic and organic fertilizers might be responsible for the higher quantity of plankton. Another cause of higher plankton population was the use of tube sampler described by Stirling (1985). Usually plankton net is used for plankton sampling through which many nanno-plankton escape whereas tube sampler allows in collecting the plankton sample from each layer without the scope of escaping.

In the present study, the total plankton was significantly higher ($P<0.01$) in the treatment receiving USG (165.59±34.47x104 cells/L) compared to that receiving normal urea (119.00±24.06x104 cells/L). Use of USG is obviously responsible for this as the other factors were same in both the treatments.

Soil quality parameters

The soil quality parameters were studied only two times in the beginning and at the end of the experiment to have an idea of the effect's of USG and normal urea on the soil quality parameters. The overall values of each parameters except available phosphorus were higher at the end than the initial value, higher in T_1 but not statistically significant ($P>0.05$). Thus, the effect of USG on soil quality parameters is similar to that of urea. The results of soil quality parameters are presented in Table 3.

Growth and production of Fishes

Details of stocking, survival, growth and production offish species are

Table 3: Status of soil quality parameters (mean±SD) at starting and at the end of the experiment.

Pammeters	Treatment 1		Treatment 2	
	At starting	At the end	At starting	At the end
Soil texture	Loam	Clay loam	Loam	Clay loam
pH	5.621-0.08	5.65±0.40	5.6310.38	6.15-10.30
Organic carbon (%)	0.996±0.18	1.833±0.12	0.83810.24	1,65910.12
Total N_2(%)	0.08310.02	0.158±0.01	0,077±0.01	0.14410.01
NH_4-N (mg/l00g)	1.331-0.49	1.75±0.30	1.05±0.10	1.33+0.10
NO_3-N (mg/l00g)	0.7010.10	0.9810.06	0.7010.10	0.8410.04
Available phosphorus (mg/l00g)	6.70±4.01	4.72±2.07	5.4511.18	3.3311.03
Available sulfur (mg/l00g)	4.04±0,37	12.1412.96	2.6311.40	7.6213.67
Potassium (mg/100g)	22.152:2.05	25.45±5.30	15.4418.20	16.00±5.23

presented in Table 4. The growth of fishes in weight under two treatments were investigated and monitored at monthly intervals. The growth of different species were more or less similar except silver carp in both the treatments. Only silver carp showed a significantly higher ($P<0.05$) growth in LISG treated treatment. There was no significant difference in the treatments in respect of survival rate and specific growth rate.

After six months of culture period, the gross production obtained were 5,387.24 kg/ha/6 months in USG treated treatment and 5,131.45 kg/ha/6 months in the treatment receiving normal urea. The average gross production of fish from ponds treated with different inorganic and organic fertilizers were reported to be 2230 to 4209 kg/ha/year (Lakshmanan *et al.* 1971), 6196 kg/ha/yr (Singh *et al.*, 1972) and 9387 kg/ha/yr (Chowdhury *et al.*, 1975). The present production seems quite satisfactory in comparison to those obtained by others. The highest average gross production was obtained from treatment receiving USG although the difference was not statistically

Table 4: Growth, survival and production of fishes under two treatments during the study period.

Treatment	Fish species	At stocking		At harvesting				Survival rate (%)	Gross production (kg/ha/6 months)		Net production (kg/ha/6 months)		SGR (%day)
		No. of fish stocked	Average initial weight(g)	No. of fish recovered	Average final weight (g)	Average weight gain(g)	(%day)		Species wise	Total wise	Species	Total	
T_1 (85 decimal)	Silver carp	1020	66.0 ±4.22	975	801.5 ±22. 78	735.50	781.46	95.59	2270.84		2083.85		1. 39
	Catla	425	60.6±4.80	404	568.1 ±32.43	507.50	229.51	95.06	666.94		595.79		1. 24
	Rohu	510	61.7± 7.51	489	598.5 ±20.99	536.80	292.66	95 .88	850.45		762.78		1. 26
	Mrigal	255	53. 9 ±6.28	243	541.2 ± 19.83	487.30	131.51	95 .29	382.16	5387. 24	344.10	4887.75	1. 28
	Common carp	255	50.0 ±4.1 9	238	458.9 ±14.26	408.50	109.22	93.33	317.38		282.52		1. 24
	Grass carp	255	63.0 ± 6.62	247	805.4 ± 46.61	742.40	200.42	96.86	582.38		532.86		1. 42
	Thai sharpunti	680	16.8 ±4.38	640	170.5 ±13.78	153.70	109.12	94.12	317.09		285.85		1. 29
T_2 (125 decimal)	Silver carp	1500	64.5 ± 4.20	1435	740.6 ±47.87	676.10	1062.76	95.67	2100.02		1917.12		1. 36
	Calla	625	59.0 ± 8. 14	593	552.7 ±55.86	493.70	327.75	94.88	647.64		578.50		1. 24
	Rohu	750	62.3 ± 4.23	721	585.8 ±66 .89	523.50	422.36	96.13	834.59		745.83		1. 25
	Mrigal	375	53. 7 ± 6.56	356	533.1 ±25 .85	479.40	189.78	94. 93	375.01	5131.45	344.27	4646.28	1. 28
	Common carp	375	51. 3 ± 5. 89	349	445.6± 18.81	394.30	155.51	93.07	307.30		271.92		1. 20
	Grass carp	375	63. 5 ± 6.77	363	792.3 ±28.21	728.80.-	287.60	96.80	568.31		522.76		1. 40
	Thai sharpunti	1000	15.5± 3.85	937	159.1 ±17.42	143.60	149.08	93.70	298. 58		265.88		1. 29

Table 5: Economics of fish production (per hectare) under two treatments

Inputs	**Rate (Tk)**	**Treatment 1**		**Treatment 2**	
		Qty/No	Price (Tk)	Qty/No	Price (Tk)
1. Seed					
Carp fingerlings	5.00/Pc	7904 PCS	39520.00	7904 PCS	39520.00
Thai sharpunti	1.00/Pc	1976 PCS	1976.00	1976 PCS	1976.00
Sub- total		9880 PCS	41496.00	9880 PCS	41496.00
2. Lime, manure and fertilizer					
Lime	6.00/kg	494.00kg	2964.00	494.00 kg	2964.00
Cow dung	0.30/kg	13338.00kg	4001.40	13338.00 kg	4001.40
USG	6.50/kg	544.00 kg	3536.00	...	
Urea	6.00/kg	………..		544.00 kg	3264.00
TSP	14.00/kg	272.00 kg	3808.00	272.00 kg	3808.00
Sub-total			14309.40		14037.40
3. Feed					
Rice bran	5.00/kg	8942.76	44713.80	8627.52	43137.60
Mustard oil cake	6.00/kg	4471.38	26828.28	4313.76	25882.56
Dried crushed fish	20.00/kg	1490.46	29809. 20	1437.92	28758.40
Sub-total			101351.28		97778.56
4. Netting	100/effort	6x 2	1200.00	6x2	1200.00
Sub-total			1200.00		1200.00
Grand total			158356.68		154511.96
Production					
Species					
Indian major carp	45.00	1899.55	85479.75	1857. 2 4	83575.80
Silver carp	35.00	2270.84	79479.40	2100.02	73500.70
Common carp	40.00	317.38	12695.20	307.30	12292.00
Grass carp	45.00	582.38	26207.10	568.31	25573.95
Thai sharpunti	40.00	317.09	12683.6	298.58	11943.20
Gross production			216545.05		206885.65
Net profit			58188.37		52373.69
Cost-benefit ratio				1: 1.37	1: 1-34

significant ($P>0.05$) from that receiving normal urea. Higher growth of silver carp due to abundance of phytoplankton in USG receiving treatment contributed for higher production.

Economic analysis

A simple economic (cost-benefit) analysis was performed to estimate the amount of profit that has been generated from these two types of treatments. The results of the analysis have been shown in Table 5. The cost of production was based on the price of Sherpur whole sale market (1999) for the input used. The cost of different inputs as well as the sell price of fishes have been shown in Table 5. The cost of leasing ponds was not included in this analysis. The cost of production was slightly higher in T_1 (Tk.. 158,356.68/ha) receiving USG than T_2 (Tk. 154,511.96/ha) receiving normal urea. The net profit was also higher in the same treatment. However, further studies with appropriate design covering more doses, frequencies and mode of USG application should be conducted in different aqua-ecological zones.

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