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Effects of Different Levels of Chemical and Organic Fertilizers on Growth, Yield and Protein Content of Wheat

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Abstract: An investigation was undertaken to study the effect of different levels of chemical and organic fertilizers on the growth, yield and protein content of two wheat varieties. Two varieties of wheat were tested, Aghrani and Kanchan with five levels of chemical and organic fertilizers viz. F_1(control), F_2, F_3, F_4 and F_5. Urea was applied in 2 splits in F_1 and in 3 splits in F_2 to F_4 as per recommendation. In F_5, it was applied in 4 equal splits. In F_1, inorganic fertilizers were applied @ 100 kg N, 36 kg P, 25 kg K and 20 kg S/ha. In F_2 to F_5, fertilizers were applied @ 120 kg N, 27 kg P, 83 kg K, 30kg S and 4 kg Zn/ha Grain yield and protein content was higher in Kanchan than Aghrani variety. Among the different levels of fertilizer application, F_5 had superior performance on all the parameters, whereas, F_1 had the most inferior effect on all the parameters including grain and straw yields. The yield, yield contributing characters and protein content of wheat increased with increase in the levels inorganic fertilizers, addition of composts with fertilizers and also by increasing split application of nitrogen.

Key words: Wheat, fertilizer, manure, wheat, grain yield, protein

Introduction

Wheat (*Triticum aestivum* L.) is the leading cereal crop of the world and the second important cereal crop of Bangladesh. Wheat is one of the cheapest sources of carbohydrate and also contains a considerable amount of protein, minerals and vitamins (Walton, 1969). Wheat cultivation is gaining popularity in Bangladesh but the average yield of this crop in the country is low as compared with other wheat growing countries of the worlds (FAO, 1998). There is a need to increase the yield of wheat per unit area in Bangladesh to meet the ever increasing food requirement of the country. There are many factors, which can help, increase wheat production of which the use of modern varieties and judicious fertilization are important. It is well recognized that crop productivity depends on adequate plant nutrient and organic matter content of the soil. Manure play an important role in improving physical, chemical and biological properties of soils. Due to low nutrient content and slow acting nature, organic manure alone may fail to meet the high nutritional requirements of crops. Some of the plant nutrients, when added to the soil in inorganic form, have low efficiency as compared with the effect of the same nutrients applied along with organic manure (Bhriguvanshi, 1988). Thus, organic manure reduce the application rate of chemical fertilizers and also help to solve the problem of micro-nutrient deficiency in the soil. In order to increase fertilizer use efficiency, top dressing and split application of nitrogenous fertilizers at critical crop growth stages of wheat are now emphasized (Singh, 1988). Randhawa *et al.* (1967) also reported that splitting nitrogenous fertilizer was more beneficial than applying a single dose at sowing. With these in view, an experiment was undertaken to study the yield performance and protein contents of two wheat varieties with inorganic fertilizers alone and in combination with organic fertilizer with increasing split application of nitrogen.

Materials and Methods

An experiment was conducted at the Agronomy field Laboratory of Bangladesh Agricultural University, Mymensingh during winter season of 1995-96. The farm was situated at 24.75° N latitude, 90.5° E longitude having sub-tropical climatic characteristics. The soil of the experimental field belongs to the Old Brahmaputra Floodplain agro-ecological zone characterized by non-calcareous dark gray soil. The experiment was laid out in a split plot design with assigning the varieties in the main plots and fertilizer treatments in subplots. The two varieties were Aghrani and Kanchan. The fertilizer treatments used were: F_1 (recommended inorganic fertilizers (control), F_2(inorganic fertilizers for high yield), F_3 (inorganic fertilizers for high yield + compost 5 t /ha), F_4 (inorganic fertilizers for high yield + compost 10 t/ha) and F_5 (inorganic fertilizers for high yield, with increased N splits + compost 10 t/ha). In F_1, inorganic fertilizers were applied as per BARI (1990) recommendation which were 100 kg N, 36 kg P, 25 kg K and 20 kg S/ha. In F_2 to F_5, inorganic fertilizers were applied as per BARC (1989) recommendations for high yield which were 120 kg N, 27 kg P, 83 kg K, 30kg S and 4 kg Zn/ha. The source of N, P, K, S and Zn was urea, triple super phosphate, muriate of potash, gypsum and zinc oxide, respectively. During final land preparation of individual plots, all inorganic fertilizers, except urea and compost were applied as basal as per requirement of the treatments. In F_1, urea was applied in 2- splits- two third as basal and one- third after 27 days of sowing. In F_2 to F_4, urea was applied in 3 equal splits as basal, after 27 and 55 days of sowing,. In F_5, urea was applied in 4 equal splits as basal, after 27, 55 and 75 days of sowing to influence grain filling and grain protein content. After land preparation, furrows were made 20 cm apart for sowing seeds. Seeds were drilled by hand in furrows on 18 December 1995 @ 120 kg/ha and then the furrows were covered with soil. The crop was adequately protected from weeds, diseases and insects pests. The data were taken plot wise at maturity of the crop the data included plant height, number of tillers per plant, length of ear, number of spikelets per ear, number of grains per spikelets, number of grains per ear and weight of 1000 grains. Grain and straw yields were recorded after drying the grain and straw of individual plot. Protein content of grain and straw was determined by following the methods as outlined by AOAC (1984). All collected data were statistically analyzed following the principle of F test and the significance of mean differences was adjudged by the least significant difference (LSD) test (Gomez and Gomez, 1984).

Results and Discussion

Varietal effect: The two wheat varieties did not vary significantly with respect to plant height, length of ear, total and fertile tillers/plant and length of spike but differed significantly in producing number of spikelets/spike, number of grains/spike and 1000-grain weight (Table 1). The variety Kanchan had the taller plants and longer ears, higher number of total and fertile tillers/plant and fertile spikelets/ear compared to those of the variety Aghrani but such increase was not statistically significant. The same variety produced significantly higher number of spikelets, grains/ear and 1000-grain weight compared to Aghrani. It was observed that Kanchan produced higher grain yield (2.55 t/ha) than Aghrani (2.23 t/ha) (Table 2). Higher grain yield in Kanchan was mainly due to the superior performance of grains/ear and 1000-grain weight. The variation in spikelet number and 1000-grain weight were for different wheat varieties were also reported by Shrestha (1988) and Amin *et al.* (1993).

Table 1: Yield parameters of wheat varieties under different levels of chemical and organic fertilizers

Factor	Plant height (cm)	Length of ear (cm)	Total tillers/ Plant (no)	Fertile tillers/ plant (no)	Total number of spikelets/ear	Fertile spikelets/ ear	No. of grains/ spikelet	No. Of grain/ ear	1000- grain weight (g)
Variety									
Aghrani	79.67	8.88	4.50	3.83	15.59	11.19	1.65	18.78	37.60
Kanchan	82.70	9.10	4.87	3.94	16.56	12.56	1.78	22.25	41.78
LSD (0.05)	NS	NS	NS	NS	0.92	NS	0.10	3.21	3.89
Fertilization									
F_1	78.69	8.43	4.18	3.42	15.25	10.41	1.49	15.31	36.59
F_2	79.46	8.70	4.53	3.90	15.72	11.41	1.66	19.03	39.04
F_3	80.30	8.97	4.62	3.97	16.37	12.09	1.71	20.68	39.89
F_4	82.07	9.17	4.97	4.00	16.45	12.95	1.76	22.65	40.26
F_5	85.43	9.69	5.13	4.17	16.58	12.53	1.97	24.90	42.67
LSD (0.05)	3.42	0.75	NS	NS	NS	NS	NS	5.71	1.77

NS = Nonsignificant

Table 2: Yield and protein contents of wheat varieties under different levels of chemical and organic fertilizers

Factor	Grain yield (t/ha)	Straw yield (t/ha)	Grain protein content (%)	Straw protein content (%)
Variety				
Aghrani	2.23	4.06	12.75	2.57
Kanchan	2.55	4.61	13.19	2.81
LSD	0.29	NS	NS	0.13
Fertilization				
F_1	2.03	3.39	12.13	2.57
F_2	2.20	3.79	12.72	2.63
F_3	2.28	4.36	13.16	2.75
F_4	2.61	4.90	13.36	2.75
F_5	2.82	5.25	13.48	2.81
LSD	0.47	1.32	NS	NS

Straw yield did not differ significantly between the varieties. Kanchan produced straw yield of 4.61 t/ha, which corresponded to its taller plants and higher number of total tillers/plant (Table 2). There was no significant difference between the varieties on protein content of grain and straw (Table 2). The variety Kanchan had the higher grain protein content (13.19%) compared to Aghrani (12.75 %). Similarly, Kanchan had higher protein content (2.81%) of straw than Aghrani (2.57%). Protein content of wheat grain was about 5 times higher than that of wheat straw.

Effect of fertilization: The different levels of fertilizer application significantly increased the plant height, length of ears, number of grains/ear and 1000-grain weight but insignificantly in total and fertile tillers/plant, total and number of fertile spikelets/ear (Table 1). Results reveals that F_5 produced the tallest plant (85.43 cm) and it was identically followed by F_4 (82.07 cm). The shortest plant was found in F_1 (78.69 cm). Plant heights of F_1, F_2, F_3 and F_4 were statistically identical. Ear length of wheat obtained from different levels of fertilization ranged from 8.43 to 9.69 cm (Table 1). The tallest ear length was produced in F_5, identically followed by F_4 and F_3. The shortest ear length was obtained from F_1, followed by F_2 and F_3, which were identical. The result is in agreement with the reported by Islam *et al.* (1999) Patel and Upadhyay (1993). The number of total and fertile tillers/plant and number of total and fertile spikelet/ear did not significantly increase due to the application of different levels of manure and fertilizers (Table 1). In all cases, the lowest number of total and fertile tillers/plant, and total spikelet/ear were found in F_1 and the highest was found in F_5 level of fertilizer application. In case of fertile spikelet/ear the lowest number was found in F_1 and the highest was found in F_4. The highest number of grains per ear (24.90) was produced in F_5, which was statistically identical with those obtained from F_4 and F_3 level of manure and fertilizer application. The lowest number of grains/ear was found in F_1 which was statistically identical to those found in F_2 and F_3. An increasing trend in 1000-grain weight was observed with increasing the levels of fertilizer and manure application. The lowest 1000-grain weight was found in F_1. The F_2 level of fertilizer application significantly increased the 1000-grain weight compared to that found in F_1 level of fertilizer application. The 1000-grain weight further increased with inclusion of composts and increase in splitting of urea-N. Patel and Upadhyay (1993) and Ahmed and Hossain (1992) also reported similar result.

The effect of different levels of fertilizer and manure application significantly increased the grain and straw yields of wheat (Table 2). The highest grain yield was obtained from F_5 (2.82 t/ha), which was possibly due to superior yield components, particularly number of grains per ear and 1000-grain weight. On the other hand, F_1 treatment produced the lowest grain yield (2.03 t/ha) due to inferior yield components. Grain yields from F_5 and F_4, from F_2, F_3 and F_4 and again from F_1, F_2 and F_3 were found to be statistically identical. F_5 produced significantly higher grain yield than F_3, F_2 and F_1, and grain yield from F_4 was higher than that from F_1.The result is in agreement with the results of Hasan *et al.* (1998). Straw yield of wheat increased with increase in fertilizer and also with increase in compost rates. The highest straw yield was obtained from F_5 (5.25 t/ha) which was identically followed by F_4 and F_3 level of manure and fertilizer application. The lowest straw yield was from F_1 (3.39 t/ha), which was identical to those obtained in F_2 and F_3. There was no significant effect on protein content and straw due to different levels of fertilizer application. Results showed that the range of protein contents of grain and straw were from 12.13 to 13.48 and 2.57 to 2.81 %, respectively. Grain protein content of wheat increased slightly due to addition of composts with inorganic fertilizers, and also with increase in splitting of urea-N.

Results of this study showed that Kanchan was a better variety than Aghrani for grain yield and protein content. The use of composts and increase in splitting of urea-N increased the yield and protein content of wheat.

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