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RESEARCH ARTICLE

Impact of different Fertilizer Combinations on the Biochemical Parameters of Wheat (*Triticum aestivum* L.)

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Abstract

In order to estimate the comparative impact of organic manure (Vermicompost, Farmyard manure), chemical fertilizers (NPK, Urea) and their combinations on protein and carbohydrate content of Wheat during different growth stages, an experiment was conducted by using Randomized Block Design (RBD) with three replications. The results revealed that at 15 days after sowing protein content of wheat (leaves) recorded maximum (15.73 mg/gm) in 10% Vermicompost +100 gm NPK fertilizer treatment and minimum (7.92 mg/gm) in control. However at 60 days after sowing it was reported maximum (17.92 mg/gm) in 10% Vermicompost +100 gm NPK fertilizer combination and minimum (9.68 mg/gm) in control. In the wheat grains, protein content was maximum (127.42 mg/gm) in 10% Vermicompost +100 gm NPK followed by 10% VC+100 gm urea (123.59 mg/gm) and minimum (87.53 mg/gm) in control. Moreover, the carbohydrate content of plant leaves at 15 days after sowing was recorded maximum (37.52 mg/gm) in 10% Vermicompost +100 gm NPK treatment and minimum (19.35 mg/gm) in control. However at 60 days after sowing it was observed maximum (39.74 mg/gm) in 10% VC+100 gm NPK and minimum (21.41 mg/gm) in control. Furthermore in grains, the carbohydrate content was observed maximum (496.72 mg/gm) in 10% FYM+100 gm NPK followed by 10% VC+100 gm urea (488.61 mg/gm).

Keywords: Vermicompost, organic manure, protein, carbohydrate, NPK, urea

Introduction

Soil is an active, living medium that is a vital part of the terrestrial ecosystem. It is a vital reserve for the production of agricultural products and also maintains the most life processes. The biological composition of per gram of soil is ten million to ten billion bacteria; ten million to one billion of actinomycetes; one lakh to one million of fungi (Coyne, 1999). The ability of soil to maintain the plant growth, which in turn results in the reliable yield and high quality of crops, is referred to as soil fertility. By the process of mineralization, the plant and animal wastes are decomposed by micro-organisms by which the inorganic nutrients are released into the soil. Due to the continuous cultivation of crops on the same soil, the fertility of the soil gets reduced resulting in the nutrient deficiency of the soil, which in turn results in the low production of next crops. In order to overcome this nutrient deficiency, there is a need for adding some extra supplements of nutrients to the soil in the form of fertilizers. Fertilizers are organic or inorganic materials of natural or synthetic origin that are added to soil to supply one or more nutrients essential for the growth and development of the plants. Organic manure or organic fertilizers are fertilizers derived from animal or plant matter (e.g. compost, manure, etc). Manure is an organic substance that is added to the soil to increase its fertility and for enhancing plant growth (Boller and Hani, 2004).

Nitrogen is the main macronutrient of plants which plays a vital role in plant growth and development. It is an integral part of proteins, enzymes and nucleic acids which are responsible for the development of chlorophyll and thus nitrogen supply has great importance for all

the crops. It has been reported that the major supply of nitrogen enhances protein synthesis to such an extent that most of the carbohydrates are used in the formation of proteins. The cultivation of wheat (*Triticum* spp.) is believed to be originated between 15,000 B.C. and 10,000 B.C. It is evolved from wild grass which is tall (2-4 feet of height), grown in all the three climatic zones (tropical, sub-tropical and temperate zones) between 47°S and 57°N latitude. The range for the cultivation of wheat in India is 10°N to 37°N latitude. For the seed germination, it needs 20°C to 25°C of temperature, while as 16°C to 22°C is the optimum range for the vegetative growth. It is the most important cereal crop of the family Poaceae and is the highest in the production of all the crops in the world. Globally the area under wheat cultivation is more than the other food crops and its trade is maximum among all the crops in the world. The approximate biochemical composition of the crop is carbohydrates (66% to 71.6%) proteins (13% to 16.7%), fats (2.5% to 3.1%) and crude fiber (2.5%-3%) (Khan, 1984). Among all the cereal grains it contains the highest vegetable protein content. Our country stands first in the area and second in terms of production of wheat after China in the world. In terms of both area and production, it is the second most important cereal crop after rice in our country. For the year 2015-16, the production of Wheat in China was 128.85 million metric tons while in India it was only 90 million metric tons. Further, the productivity of Wheat in Egypt for 2015-16 was 6.43 metric tons per hectare, while in India it was only 2749.9 Kg/ha and in Madhya Pradesh, the productivity was 2849.7 kg/ha (Indiastat, 2017).

Wheat (*Triticum aestivum*) being a very important crop of India in general and of Madhya Pradesh in particular, but its productivity is often limited by the low availability of essential nutrients or imbalanced nutrition forming one of the important reasons for low productivity of wheat crop in Madhya Pradesh (India). Hence a balanced nutrient application is a must to harness the productivity of the crops. Black cotton soil is deficient in nitrogen, phosphoric acid, and organic matter but rich in calcium, potash, and magnesium. In India, approximately 20% of the land is occupied by black cotton soil.

So taking the above facts under consideration, the present study was conducted in order to study the comparative effectiveness of organic manure, chemical fertilizer and their combinations on the protein and carbohydrate content of wheat on the black cotton soil

Materials and Methods

The research work was carried out under field conditions at the "Botanical Garden" of Govt. Madhav Science PG College, Ujjain, M.P., by using "Black cotton soil" which was not previously treated with any type of fertilizer or pesticide. The field was prepared up to a depth of 20 cm.

Treatment details

The nine treatments each of the size of 1 m^2 are;

T1=Control (no fertilizer) **T2**=20% Farmyard manure (FYM)

T3=20% Vermicompost (VC) **T4**=200 gm NPK

T5=10% FYM+100 gm NPK **T6**=10% VC+100 gm NPK

T7=200 gm Urea **T8**=10% FYM+100 gm Urea

T9=10% VC+100 gm Urea

Where,

20% of organic manure (VC or FYM)=20% of the 1 m^2 soil i.e. 20 cm^2 soil up to the depth of 20 cm.

10% of organic manure (VC or FYM)=10% of the 1 m^2 soil i.e. 10 cm^2 soil up to the depth of 20 cm.

Plant material

The healthy and certified seeds of Lok-1 cultivar were used in the present study which was brought from the KVK (Krishi Vigyan Kendra) Ujjain. About 150 seeds were sown in field trials with three replicates for each treatment in a Randomized Block Design.

Experimental details

Design=Randomized block design

Replications=3 (three)

Treatments=9 (nine)

Plot size=1 m^2

Physico-chemical parameters of the soil, vermicompost (VC) and farmyard manure (FYM)

The various Physico-chemical parameters studied in the present study are, pH, Electric Conductivity (EC), Organic carbon (OC), Nitrogen (N), Phosphorus (P), Potassium (K), Zinc (Zn), Copper (Cu), Iron (Fe), Manganese (Mn). The estimation of pH was performed according to the method given by Jackson (1967) by using standard digital pH meter. Electric Conductivity (EC) was evaluated according to the method proposed by Jackson (1967) by using a Conductivity meter. Organic carbon (OC) was performed according to the method given by Walkley and Blacks (1934). Nitrogen (N) content was performed according to the method proposed by Saxena (1989). Phosphorus (P), Potassium (K), Zinc (Zn), Copper (Cu), Iron (Fe) content was performed according to APHA, AWWA, WPCA (1998) Environmental analysis: Water, Soil and Air. Agro Botanical Publishers, India.

Biochemical parameters

The protein content of plant leaves and seeds of wheat was performed according to the method given by Lowry

et al., (1951) while the carbohydrate content was evaluated in plant leaves and seeds of the crop according to Phenol-Sulphuric acid method proposed by Dubios et al., 1951.

Results and Discussion

Results regarding Physico-chemical parameters and nutrient analysis of Soil, Vermicompost and Farmyard manure are given in Tab. 1.

The results explored that protein content was recorded maximum in 10% VC+100 gm NPK (15.73 mg/gm), followed by 10% VC+100 gm urea (14.68 mg/gm), 10% FYM+ 100 gm NPK (12.24 mg/gm), 20% VC (11.42 mg/gm), 10% FYM+100 gm urea (10.95 mg/gm), 20% FYM (9.53 mg/gm), 200 gm urea (9.32 mg/gm), 200 gm NPK (9.24 mg/gm) and minimum in control (7.92 mg/gm) at 15 days after sowing. At 30 days after sowing it was reported maximum in 10% VC+100 gm NPK (16.42 mg/gm) followed by 10% FYM +100 gm NPK (15.54 mg/gm), 10% FYM+100 gm NPK (12.83 mg/gm), 20% VC (11.93 mg/gm), 10% FYM+100 gm urea (11.58 mg/gm) and minimum in control (8.45 mg/gm).

Protein content of grains (seeds)

The results revealed that protein content in the seeds of wheat was maximum in 10% VC+100 gm NPK (127.42 mg/gm) followed by 10% VC+100 gm urea (123.59 mg/gm), 20% VC (121.74 mg/gm), 10% FYM+100 gm NPK (120.78 mg/gm), 10% FYM+100 gm urea (118.47 mg/gm), 20% FYM (115.51 mg/gm), 200 gm NPK (111.68 mg/gm) and 200 gm urea (108.54 mg/gm) treatment. The minimum protein content was recorded in control (87.53 mg/gm) treatment.

Carbohydrate content of wheat leaves

Results related to the carbohydrate content of wheat leaves are given in the Tab. 2. Carbohydrate content of plant leaves of wheat at 15 days after sowing was recorded maximum in 10% VC+100 gm NPK (37.52 mg/gm) followed by 10% VC+100 gm urea (35.61 mg/gm), 200 gm urea (30.52 mg/gm), 10% FYM+100 gm NPK (30.23 mg/gm), 200 gm NPK (29.46 mg/gm), 10% FYM+100 gm urea (28.93 mg/gm), 20% VC (29.14 mg/gm), 20% FYM (28.75 mg/gm) and minimum was recorded in control (19.35 mg/gm).

At 30 days it was observed highest in 10% VC+100 gm NPK (38.31 mg/gm) followed by 10% VC+100 gm urea (36.53 mg/gm), 200 gm urea (31.33 mg/gm), 10% FYM +100 gm NPK (30.86 mg/gm), 200 gm NPK (30.25 mg/gm), 10% FYM+100 gm urea (30.12 mg/gm), 200 gm VC (30.25 mg/gm), 20% FYM (29.83 mg/gm) and lowest in control (19.96 mg/gm). Furthermore it was recorded maximum in 10% VC+100 gm NPK (38.92 mg/gm) followed by 10% VC+100 gm urea (37.56 mg/gm), 200 gm urea (31.93 mg/gm), 20% VC (31.86 mg/gm), 10% FYM +100 gm urea (31.83 mg/gm), 10% FYM+100 gm NPK (31.27 mg/gm), 20% FYM (30.92 mg/gm), 200 gm NPK (30.84 mg/gm) and minimum in control (20.62 mg/gm) at 45 days after sowing. At 60 days after sowing the carbohydrate content of wheat was observed maximum in 10% VC+100 gm NPK (39.74 mg/gm) followed by 10% VC+100 gm urea (38.48 mg/gm), 20% VC (33.41 mg/gm), 10% FYM+100 gm urea (33.13 mg/gm), 10% FYM+100 gm NPK (32.97 mg/gm), 200 gm urea (32.16 mg/gm), 20% FYM (32.15 mg/gm), 10% FYM+100 gm NPK (31.98 mg/gm).

Table 1. Physico-chemical (quality) parameters of Soil, Farmyard manure, and Vermicompost before starting the experiments.

Type of Material	pH	EC (ds/m)	OC (g/kg)	N (Kg/ha)	P (kg/ha)	K (kg/ha)	Zn (ppm)	Cu (ppm)	Fe (ppm)	Mn (ppm)
Soil	7.6 ± 0.19	0.42 ± 0.02	5.63 ± 0.34	95.62 ± 1.67	7.63 ± 0.94	146.53 ± 2.45	0.59 ± 0.06	3.88 ± 0.21	2.87 ± 0.13	2.46 ± 0.16
Farmyard manure	7.43 ± 0.16	1.63 ± 0.04	196.46 ± 1.13	233.46 ± 1.16	50.16 ± 1.10	396.37 ± 2.64	291.52 ± 1.47	273.52 ± 1.52	212.34 ± 1.44	214.15 ± 1.62
Vermi-compost	7.14 ± 0.12	1.84 ± 0.02	198.53 ± 0.92	246.57 ± 0.85	55.24 ± 0.91	438.52 ± 2.04	320.13 ± 1.16	289.34 ± 1.41	239.24 ± 1.51	248.37 ± 1.24

EC=Electric Conductivity; OC=Organic Carbon; ±=Standard Deviation (SD)

Table 2. The protein content of Wheat (leaves) at different growth stages.

Treatment	Protein content (mg/gm)			
	15 Days	30 Days	45 Days	60 Days
Control (T1)	7.92 ± 0.97	8.45 ± 0.95	8.86 ± 0.96	9.68 ± 0.99
20% FYM (T2)	9.53 ± 1.14	9.94 ± 1.17	10.81 ± 1.16	11.04 ± 1.18
20% VC (T3)	11.42 ± 1.25	11.93 ± 1.27	12.65 ± 1.28	12.73 ± 1.26
200 gm NPK (T4)	9.24 ± 1.07	10.13 ± 1.13	10.61 ± 1.17	10.69 ± 1.22
10% FYM+100 gm NPK (T5)	12.24 ± 1.26	12.83 ± 1.28	13.52 ± 1.30	13.95 ± 1.33
10% VC+100 gm NPK (T6)	15.73 ± 1.39	16.42 ± 1.41	17.15 ± 1.43	17.92 ± 1.46
200 gm Urea (T7)	9.32 ± 1.05	10.18 ± 1.12	10.69 ± 1.16	10.78 ± 1.19
10% FYM+100 gm Urea (T8)	10.95 ± 1.20	11.58 ± 1.24	12.43 ± 1.27	12.87 ± 1.26
10% VC+100 gm Urea (T9)	14.68 ± 1.37	15.54 ± 1.42	16.34 ± 1.40	16.85 ± 1.45

The value given in each cell of the table is mean value; value along with ± sign represents the standard deviation (SD)

The carbohydrate content was found minimum in control (21.41 mg/gm) treatment.

The study explored that the protein content of soybean and wheat showed more increment by the integrated application of organic manure and chemical fertilizer. The application of vermicompost along with chemical fertilizer (NPK) is more beneficial for the improvement of the protein content of both the crops. The protein content of plant leaves was increased with the increase in the growth and age of both the crops. Dwivedi et al. (2014) reported that the application of vermicompost significantly increased the protein content in the plant leaves of soybean as compared to the control ones (Tab. 3).

The production of the higher protein content of soybean primarily depends on the availability of a sufficient amount of nitrogen in the soil, uptake as well as the metabolism of nitrogen. El-Essawai and Abadi (1990) evaluated that the protein content of soybean is significantly enhanced by the presence of an excess supply of nitrogen, phosphorus, and potassium in the soil. Yaklich and Vinyard (2004) and Hyten et al. (2004) revealed that the process of nitrogen fixation gets minimized by the insufficient supply of nutrients (fertilizer) in the rhizosphere which results in the reduction of protein synthesis consequently leads to a reduction of the protein content of the plant leaves and seeds in soybean. Also, the lower protein might be due to the deficiency of some type of nutrients in the soil (Deosarkar et al., 2002). Similarly, Yassen et al. (2006) and Khalil et al. (2006) explored that the protein content in wheat was significantly increased by the availability of nitrogen and other mineral nutrients as compared to the control (soil with insufficient nutrients).

However, the maximum protein was observed by the application of VC+NPK and FYM+NPK fertilizer which might be due to better root growth and nutrient uptake supplied from the balanced use of chemical fertilizer (NPK, urea) along with organic manure (FYM, VC). Similar results regarding the protein content were observed by Singh et al. (2003) and Patil et al. (2003).

Carbohydrate content of seeds

The results explored that carbohydrate content in the seeds of wheat was observed maximum in 10% FYM +100 gm NPK (496.72 mg/gm), followed by 10% VC +100 gm urea (488.61 mg/gm), 10% FYM+100 gm NPK (486.75 mg/gm), 20% VC (485.73 mg/gm), 10% FYM +100 gm urea (477.43 mg/gm), 20% FYM (464.21 mg/gm), 200 gm NPK (470.47 mg/gm), 200 gm urea (451.84 mg/gm) and minimum (408.65 mg/gm) carbohydrate content was recorded in control (Tab. 4).

The study revealed that carbohydrate content increased by the application of the combination of organic manure and chemical fertilizer. Vermicompost along with chemical fertilizer (NPK) showed a maximum increase in the carbohydrate content. The application of

Table 3. Carbohydrate content of Wheat (leaves) at different growth stages.

Treatment	Carbohydrate content (mg/gm)			
	15 Days	30 Days	45 Days	60 Days
Control (T1)	19.35 ± 0.89	19.96 ± 0.92	20.62 ± 0.95	20.85 ± 0.96
20% FYM (T2)	28.75 ± 0.96	29.83 ± 1.10	30.92 ± 1.14	32.15 ± 1.12
20% VC (T3)	29.14 ± 1.14	30.25 ± 1.17	31.86 ± 1.23	33.41 ± 1.19
200 gm NPK (T4)	29.46 ± 1.12	30.25 ± 1.14	30.84 ± 1.17	31.28 ± 1.14
10% FYM+100 gm NPK (T5)	30.23 ± 1.15	30.86 ± 1.17	31.27 ± 1.16	32.97 ± 1.18
10% VC+100 gm NPK (T6)	37.52 ± 1.21	38.31 ± 1.24	38.92 ± 1.26	39.74 ± 1.22
200 gm Urea (T7)	30.52 ± 1.24	31.33 ± 1.23	31.93 ± 1.26	32.16 ± 1.28
10% FYM+100 gm Urea (T8)	28.93 ± 1.32	30.12 ± 1.28	31.83 ± 1.24	33.13 ± 1.34
10% VC+100 gm Urea (T9)	35.61 ± 1.36	36.53 ± 1.34	37.56 ± 1.37	38.48 ± 1.33

The value given in each cell of the table is mean value; value along with ± sign represents the standard deviation (SD)

Table 4. Protein and Carbohydrate content of Wheat seeds.

Treatment	Protein content (mg/gm)	Carbohydrate content (mg/gm)
Control (T1)	87.53 ± 0.82	408.65 ± 0.97
20% FYM (T2)	115.51 ± 0.95	464.21 ± 1.26
20% VC (T3)	121.74 ± 0.98	485.73 ± 1.35
200 gm NPK (T4)	111.68 ± 0.92	470.47 ± 1.32
10% FYM+100 gm NPK (T5)	120.78 ± 0.94	486.75 ± 1.36
10% VC+100 gm NPK (T6)	127.42 ± 1.12	496.72 ± 1.41
200 gm Urea (T7)	108.54 ± 0.96	451.84 ± 1.29
10% FYM+100 gm Urea (T8)	118.47 ± 0.95	477.43 ± 1.34
10% VC+100 gm Urea (T9)	123.59 ± 0.10	488.61 ± 1.45
LSD (≤ 0.05)	11.27	43.04

The value given in each cell of the table is mean value; value along with ± sign represents the standard deviation (SD). LSD=Least Significant Difference

organic manure (VC, FYM) and combination of organic manure and chemical fertilizer (urea, NPK) significantly improved the protein and carbohydrate content of plant leaves and seeds of soybean and wheat crops. The results are in accordance with Mohil and Jain (2014) who reported that the application of vermicompost along with chemical fertilizer significantly increased the protein and carbohydrate content of soybean.

In both the crops the data regarding protein and carbohydrate content of soybean and wheat seeds were statistically analyzed through LSD and was found significant ($p \leq 0.05$) compared with the control ones.

Moreover, the carbohydrate and protein content of groundnut was increased by the application of vermicompost (Mathivanan et al., 2012). Yousefi and Sadeghi (2014) reported that the plant growth, protein and carbohydrate content of wheat was significantly enhanced by using VC and FYM. Agarwal et al. (2003) revealed that the carbohydrate and protein content of wheat was significantly improved on the application of vermicompost.

Ghosh et al. (2003) explored that the application of farmyard manure (FYM) improved the protein and carbohydrate content of soybean and showed more increment by using NPK fertilizer along with FYM. The protein and carbohydrate content of wheat was significantly improved by the application of farmyard manure (Ganai, 1983; Sharma, 1992). Malghani et al. (2010) reported that the application of NPK fertilizer significantly enhanced the protein and carbohydrate content of wheat. Yagoub et al. (2012) investigated that the application of urea and NPK fertilizer increased the protein and carbohydrate content of soybean and was found more by using NPK than the urea fertilizer. Furthermore by the availability of sufficient (balance) minerals the carbohydrate and fat (lipid) metabolism gets accelerated (enhanced) (Singh et al., 2003; Patil et al., 2003).

The combination of organic manure and chemical fertilizer significantly improves the protein and carbohydrate content of wheat (Tahir et al., 2011). Sharma et al. (2014) reported that the application of farmyard manure along with NPK fertilizer significantly improved the protein and carbohydrate content of wheat. Lakshmisha et al. (2012) explored that the combination of farmyard manure and chemical fertilizer significantly increased the chlorophyll, protein, oil and carbohydrate content of soybean. Moreover, the integrated application of organic manure (FYM) along with chemical fertilizer (NPK) significantly improved the protein and carbohydrate content of soybean and wheat crops (Dwivedi et al., 2007).

Conclusion

Organic manure (Vermicompost, Farmyard manure) is more beneficial than the chemical fertilizer (NPK, Urea) for enhancing the biochemical parameters (protein, carbohydrate) of wheat. The conjoint application of vermicompost and NPK fertilizer is the most efficient fertilizer combination for the better improvement of biochemical parameters of wheat which ultimately leads to the higher production (yield) of the crop.

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