



Influence of organic and inorganic plant nutrient sources on wheat (*Triticum aestivum*)

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Abstract

The study was made on the topic entitled “Influence of Organic and Inorganic Plant Nutrient Sources on Wheat (*Triticum aestivum*)”. The complete study included as pot experiments conducted at the department of Soil Science and Agricultural chemistry, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi. The main crop was wheat (HUW-533) grown in sandy loam soil in two consecutive years. The experiment was laid out in Completely Randomized Block Design with twelve treatments replicated three times. The main idea was to assess the beneficial effect of organic sources of nutrients on crop production when applied with inorganic fertilizers. The main recommendation was 120 kg N, 60 kg P₂O₅ and 60 kg K₂O ha⁻¹. These recommended doses were applied through chemical fertilizers and also organics (FYM, press mud, carpet waste, digested sludge and poultry manure) to add the amount equivalent to 10 kg N per hectare. This all gave twelve treatments e.g. T₁: (Control), T₂: [Full dose of NPK (N: P₂O₅:K₂O) 120 : 60 : 60], T₃: [Full dose of NPK + 2 tonne ha⁻¹ FYM (equivalent to 10 kg N)], T₄: [Full dose of NPK + 85 kg CW ha⁻¹ (equivalent to 10 kg N)], T₅: [Full dose of NPK + 1 tonne PM ha⁻¹ (equivalent to 10 kg N)], T₆: [Full dose of NPK + 1 tonne DS ha⁻¹ + equivalent to 10 kg N], T₇: [Full dose of NPK + 0.4 tonne PyM ha⁻¹ (equivalent to 10 kg N)], T₈: 120 kg N as FYM (24 tonne ha⁻¹ + PK), T₉: 120 kg N as CW (1 tonne ha⁻¹ + PK), T₁₀: 120 kg N as PM (12 tonne ha⁻¹ + PK), T₁₁: 120 kg N as DS (12 tonne ha⁻¹ + PK) and T₁₂: 120 kg N as PyM (5 tonne ha⁻¹ + PK). N, P, K were applied through urea, single super phosphate and muriate of potash respectively. Application of N, P, K followed the recommended pattern. While the total amount of organics were applied 14 days before sowing of the wheat crop. The response of wheat crop to the various treatments was measured in terms of quantitative expression. The quantitative indices included observations on number of tillers (pot⁻¹), plant height (cm.), grain and straw yield (g pot⁻¹). Application of recommended doses of fertilizers along with 10 kg N ha⁻¹ through various organic sources (T₃ to T₇) brought about maximum improvement in the different growth attributes such as total tillers and plant height in comparison to other alone sources of N carriers. These attributes were also observed to increase significantly (pooled data) over control (T₁) except in T₈ and T₁₁, among which the combination of three organics [(T₄-RDF + 10 kg N through C.W), (T₃-RDF + 10 kg N through FYM) and d (T₇ - RDF + 10 kg N through PyM)] proved to be superior. Among the all treated condition the values were found at par with each other in the treatment of T₃ to T₇ and T₈ to T₁₂. Application of N through different sources in the different treatments brought about significant improvement in grain and straw yield of wheat crop over the control (T₁) and integrated use (T₃ to T₇) established superiority over rest of the treatments. Among organic N sources application of N through carpet waste (T₉) increased the grain and straw yield as against rest of the organic N sources and the control (T₁ - lowest yield). Pooled grain and straw yield were showed at par in the treatments of T₃ to T₇; T₂ and T₈ to T₁₂.

Keywords: Inorganic plant, *Triticum aestivum*, agricultural technologies

Introduction

The population of the country was within limit during ancient time and food production was sufficient to feed the population. But with the passage of time, population growth rate became more as compared to increase in food production. With the result scarcity of food started coming up and it became the cause of concerned authorities. Attempts were started to boost the production by various manipulations of agricultural technologies and inputs. In the meantime, during the last sixties, ‘green revolution’ came into existence which brought tremendous boost to the agricultural production in India due to greater use of high yielding varieties of wheat, more fertilizers, pest management and improved agricultural technologies. Increased yield ha⁻¹ of wheat results in greater removal of

nutrients from soil and use of high analysis fertilizers was unable to supplement all nutrient elements. The use of organic manures went on decreasing due to their limited availability resulting in stagnation or decrease in fertility status of soil. This also affected the biological characters of soils and lead to decline in soil quality and soil health.

The subsequent effect was observed in decrease of soil productivity. The gravity of deterioration in soil quality was realized by scientists and they started giving attention on the greater use of organic residues and manures along with inorganic fertilizers to narrow down the gap between the additions and removal of nutrients by crops as well as to sustain the quality of soil to achieve higher crop productivity, improvement of soil health as well as nutrient use efficiency, presently, besides green manures, farm yard

manure and some organic residues available at farms, certain organic wastes like sludge, carpet-wastes, pressmud, crop residue management, natural farming, uses of vermicompost and bioformulations etc. have also drawn the attention of soil scientists and some research worker have also been carried out with these waste materials alone as well as in combination with inorganic fertilizers. Shibahara and Inubushik (1997) ^[11], Togmitova *et al.* (1998) ^[16] and Palaniappan and Annandurai (1999), on the basis of their research findings advocated for the maintenance of soil productivity through the use of crop residues, animal manures, green manures, off farm organic wastes. Yadav *et al.* (2000) ^[19] also come with the idea that sustained yield and soil productivity can be accomplished with balanced nutrient addition using organic manures and/or chemical fertilizers. Integrated use of organic manures and fertilizers, besides improving soil quality and supply of NPK, also help in alleviating the increasing incidence of deficiency of secondary and micronutrients.

Materials and methods

This chapter elaborates the materials used, experimental procedures followed and techniques adopted during the present investigations. The present investigation entitled "Influence of Organic and Inorganic Plant Nutrient Sources on Wheat (*Triticum aestivum*)", involving pot experiments which was carried out on the soils of Agricultural Research Farm of Banaras Hindu University, Varanasi during *rabi* seasons of 2004-05 and 2005-06.

Location and climate

The research farm is located at South-East end of the Varanasi City at 82° 14' E longitude and 25° 18' N latitude with an altitude of 77.72 m above the sea level. This district falls under semi-arid to sub-humid climatic belt having hot summer and cold winter. In Indian agroecological zone, the area falls under V-eastern plain zone. The temperature begins to rise from middle of February and reaches its maximum by the end of May or middle of June. May and June are the hottest months mean maximum temperature ranging from 39°C to 42°C. However, the coldest period lies between the last week of December and first week of January with minimum temperature varying between 9°C to 10°C. The normal period for onset of monsoon in the region is third week of June which lasts upto the end of September or sometimes in the first week of October. The areas occasionally experiences some showers of winter cyclonic rains during December to February. The normal annual rainfall of this region is about 1100 mm. In terms of percentage of total rainfall, about 84% is received from June to September, 0.7% from October to December, 6% from January to February and 9.30% from March to May as premonsoon rain. The mean relative humidity of this region is about 68% with maximum of 82% and minimum of 30% during July to September and April to early June, respectively.

The soils of Varanasi region formed due to deposition of alluvium by river Ganges and have predominance of illite, quartz and feldspar minerals. Illitic minerals are partly inherited from micas which are predominant in the sand and silt fractions. Quartz and feldspar in the soil are supposed to be inherited from the parent materials. Most of the soils of the Varanasi division have been classified in the soil order of Inceptisol (Udic, Ustochrept).

The soil, used for pot experimentations, was collected from the NC-1 block of the Research Farm, Institute of Agricultural Sciences, BHU, Varanasi. The soils of this site fall under Inceptisol with low, medium and high fertility status of nitrogen, phosphorus and potassium. The details of physico-chemical and biological properties of the experimental soil have been discussed in the chapters of.

Organic Materials Used as Nutrient Sources

- a. **Farm yard Manure (FYM):** It was obtained from the Dairy Farm of BHU.
- b. **Carpet-waste (CW):** District Bhadohi in U.P. is well known for manufacturing of quality carpets. Many waste materials come out during the processing of carpet threads. These waste materials are known as carpet waste which is infact creating environmental problem. However, it is having nutritional value particularly in terms of nitrogen value and is useful as organic source of nutrients. Carpet waste was collected from the carpet industries of district Bhadohi.
- c. **Press mud (PM):** Press-mud was collected from Aurai sugar mill district Mirzapur, U.P.
- d. **Digested sludge (DS):** Digested sludge was collected from sewage treatment plant (STP), Dinapur near DLW, Varanasi.
- e. **Poultry-manure (PyM):** Poultry manure was collected from Satau Mahua, Varanasi.
- f. **Fertilizer sources:** For nitrogen, phosphorus and potash urea, single super phosphate and potassium chloride were used for the supply of N, P and K respectively.

All the organic sources of nutrients were air-dried, ground and sieved from 2 mm sieve. The processed materials were analyzed for their physico-chemical properties and nutritional values for the purpose of their use in in pot culture studies.

Pot Culture Experiments: Two sets of pot culture experiments, one in *rabi* season of 2004-05 and another in *rabi* season of 2005-06 were conducted in lysimeter of the Department of Soil Science and Agricultural Chemistry, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi.

Pot Filling: Eight kg soil was filled in suitable earthen pot. All pots were lined with polythene for checking the nutrient loss and nutrient interaction with earthen pots. Crop sowing is done on dated 15 November in the both years of experimentation.

Pot Operations

1. Application of nutrient sources: The total amount of organic manures/wastes, *viz.* FYM, CW, PM, DS, PyM were applied 7 days before sowing of the wheat in order to facilitate the complete decomposition of organic manures/wastes. The organic manures/wastes were uniformly mixed with soil and applied on the basis of nitrogen content as per treatments. Nitrogen through urea was applied in two splits, half at basal and half at tillering

stage whereas the total amount of P₂O₅ and K₂O were applied at the time of sowing of seed.

2. Sowing of wheat: Sowing of wheat was done on 15th November, 2005. A well pulverized but firm soil condition is imperative to attain uniform and good germination of wheat. Ten seeds were sown initially but after proper germination of seeds, thinning was done to maintain 5 seedlings at uniform distance.

3. Intercultural operations: Weeding was done as and when required. Weeding was done by manual means. The agronomic intercultural operations were done from time to time for maintaining proper condition.

4. Irrigation: Irrigation was duly given frequently and whenever required to maintain field capacity condition in experimental soil throughout crop growth in lysimeter.

Harvesting: The experimental crop of wheat was harvested at proper maturity stage. The harvested experimental crop was tagged. After tagging fresh weight was taken immediately. Then these experimental samples were allowed to dry first in air then hot oven at 70^oC. After this dry weight was taken immediately. Harvesting was done 15th March.

Threshing: The weighed samples of wheat were threshed manually. The grain and straw weight were recorded (g pot⁻¹) by subtracting grain weight from total biomass after winnowing and cleaning.

Experimental Observation: Different growth characters and yield attributes were recorded. The following observations were recorded.

Growth Characters

Plant height: Plant height as pre-harvest observation was recorded by measuring it from the soil surface to tip of the topmost leaf and average height was taken. Plant height was taken at different stages of crop growth.

Total number of tillers per pot: Total number of tillers per pot was recorded after harvest of crop.

Yield attributes: Ear bearing tillers of each pot were counted. After that mean of all three replications was taken.

Grain and straw yield (in gram): The harvested material from each replication was weighed and threshed. The grains are separated, cleaned, winnowed and weights were recorded. The grain yield was deducted from sample weight. Grain and straw yields (g pot⁻¹) was computed.

Statistical Analysis: All the experimental data of soil, plant and soil microorganism were statistically analysed to drawn conclusion of significance by using the method as prescribed by Panse and Sukhatme (1967) [9]. The test of significance was carried out at 5% level of significance by referring to 'F' table value. Critical differences were worked out for the effects which were significant.

Table 1: Methods used for organic manure analysis

Parameter	Method used	References
Organic carbon	Wet chromic acid digestion	Walkley and Black's (1934) [18]
Total N	Distillation in 'Kelplus' N-estimation system	Tandon H.L.S. (1988) [14]
Total P	Vanado-molybdo phosphoric acid yellow colour method	Jackson (1967) [2]
Total K	Flame photometer	Jackson (1967) [2]
Micronutrients	Atomic absorption spectrophotometer	Tandon H.L.S. (1988) [14]
W.H.C. (%)	Keen box	Black <i>et al.</i> (1965) [11]
pH (1:2.5 manure water suspension)	Glass electrode pH meter	Jackson (1973) [3]

Results & discussion

Physico-chemical properties of organic sources used during experimentations: The locally available organic wastes such as digested sludge (DS), farm yard manure (FYM), carpet waste (CW), sulphinated pressmud (PM) and poultry manure (PyM) were analyzed for the evaluation of the manurial value i.e., for the plant nutrients present in them. The data regarding chemical composition of organic wastes are given in table 2. As indicated by chemical composition of organic wastes, the water holding capacity, organic carbon and nitrogen content were highest in woolen carpet waste and while phosphorus and potassium contents were highest in poultry manure. As far as Zn, Cu, Fe, and

Mn are concerned; these were more in PM and DS than CW, PyM and FYM.

The nutrient status of the different organic wastes employed in this experiment was in the following order:

Nutrient contents in organics

N = CW > PyM > PM = DS > FYM
 P = PyM > PM > DS > FYM > CW
 K = PyM > FYM > DS > PM > CW
 Zn = DS > PM > PyM = CW > FYM
 Cu = PM > DS > PyM > CW > FYM
 Fe = PM > DS > FYM > PyM > CW
 Mn = PM > DS > PyM > FYM > CW

Table 2: Physico-chemical properties and nutrient contents in various organic sources.

Parameters	Organic Sources				
	FYM	CW	PM	DS	PyM
WHC (%)	121.22	334.80	211.80	89.50	121.22
pH	6.7	7.3	7.2	7.4	6.9
Organic carbon (%)	18.50	56.55	15.08	8.70	13.25
N (%)	0.5	12.0	1.0	1.0	2.5
P (%)	0.38	0.05	0.94	0.40	1.9
K (%)	0.90	0.05	0.28	0.33	1.6

Micronutrients (mg kg ⁻¹)					
Zn	40	90	440	760	90
Cu	2.8	20	260	130	71
Fe	1665	20	5040	4740	1400
Mn	40	20	460	250	90
C: N ratio	37.0	4.52	14.36	5.03	5.26

HUW – 533 characteristics: It was developed from the Institute of Agricultural Sciences, B.H.U., Varanasi and recommended for timely sowing under irrigated conditions for north eastern plain zones. It has tremendous yield potential and excellent tall variety and high dry matter producer per unit area. It has wider adaptability and amber hard, good shining and lustrous grains.

Effect of organic and inorganic sources of nutrients on yield attributes of wheat: Results pertaining to the effect of organic and inorganic sources of nutrients on average number of tillers and plant height of wheat at harvest have been presented in figure 1 & 2. The number of tillers pot⁻¹ and plant height of wheat were in the range of 8.33 to 13.33 and 100.25 to 123.00 cm during 2004-05; and 10.0 to 14.60 pot⁻¹ and 103.17 to 125.58 cm during 2005-06, respectively. Similarly, the pooled data of the both years have shown number of tillers in the range of 9.17 to 14.00 pot⁻¹ and plant height 101.71 to 124.29 cm. The minimum values of the both parameters were observed in control (T₁) treatment while, maximum was due to combined treatment of 100% NPK + C.W. (T₄). All the treatments have shown significant increase in number of tillers or control except organic treatment of FYM (T₈), press mud (T₁₀) and digested sludge (T₁₁) in both years. However, considering the plant height, all the treatments of inorganic or organic or both in integration have shown significant enhancement over the control. The treatment of integrated approaches of 100% recommended NPK along with different organic sources equivalent to 10 kg N ha⁻¹ were found significantly superior in both parameters compare to alone treatments of inorganic or organic sources during each year and in pooled data. In the pooled data of both parameters were found at par with each other in the treatments of T₃ of T₇ and T₈ to T₁₂.

In the present study, the marked increase in both parameter is attributed by defferent factors by the application of different treatments. Application of N @ 120 kg ha⁻¹ along with 10 kg N through organic sources was effective for plant growth of wheat in both of the experiments. The similar results also reported by Wajid *et.al* (2002)^[17]. Singh *et al.*, (2002)^[12, 13] found that the different growth parameters including plant height and tillers plant⁻¹ increased with increasing supply of nitrogen. The increase in plant height is due to protein synthesis and increased

protoplasmic cell size within cell-wall (Chandler; 1969)^[5, 6]. As compared to control treatment, receiving inorganic and organic nutrients in integration have proved high effectiveness in increasing the number of tillers and plant height pot-1, significantly over most of the treatments. Increasing availability of N from the native sources of the soil and organics due to slow and steady release of N along with other nutrients through mineralization process was the reason behind significant increase in plant height.

Effect of organic and inorganic sources of nutrients on wheat yield (Pot experiment): The data of grain and straw yield of both the years have been presented in figure 3. The pooled data have also been given. The observation of data of both the years has revealed that the maximum return was from T₄ treatment, i.e., full does of NPK along with 85 kg ha⁻¹ carpet waste. Looking at the CD value T₃, T₄, T₅, T₆, and T₇ treatment exhibited almost at par results. The pooled data have shown the same trend of variation. Undoubtedly, the minimum values were from control in case of grain and straw yields. Straw yield was greater than grain yield with maximum value (21.42 g pot⁻¹) in 2004-05 and (23.92 g pot⁻¹) in 2005-06. As such all the treatments have shown significant increase in yield over control during both the years. Looking at the individual treatment effect, the combined application of inorganic and organic sources was more effective then individual treatments. Supply of N in balance quantity enabled the wheat plants to assimilate sufficient photosynthetic products and, thus, increased dry matter and photosynthetic products, coupled with efficient translocation, plant produced more panicles with more number of fertile grains with increased test weight and ultimately higher grain yield. Datta; (1996)^[7], Biswas and Dravid (1998)^[4]; Ram *et. al.* (2000)^[10] and Tiwari (2002)^[15] had also reported positive effect of digested sludge, carpet waste and press mud on yield of crops. As such the beneficial effect of any treatment on one or more of yield attributing characters will result in an increased yield. Among integrated N sources, incorporation nutrients in the form of full dose of NPK + 10 kg N ha⁻¹ through CW (T₄) was superior to other organic N sources incorporated as an independent ones (T₈ to T₁₂) and also 100% N through urea (T₂).

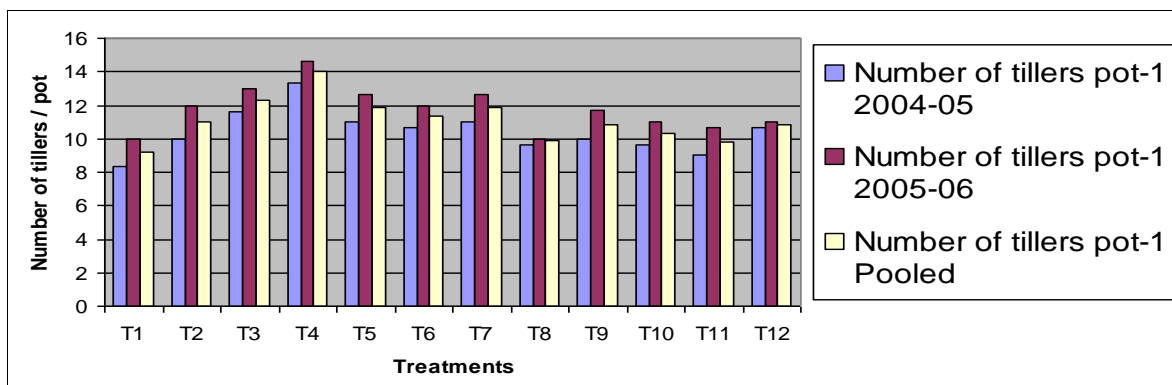


Fig 1: Effect of organic and inorganic sources of nutrients on number of tillers of wheat

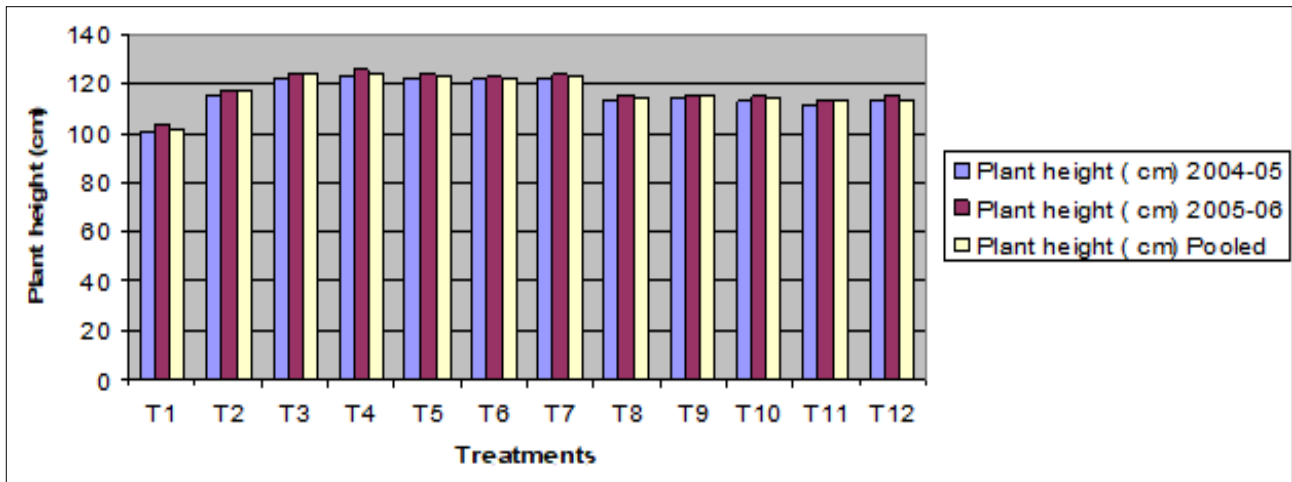


Fig 2: Effect of organic and inorganic sources of nutrients on plant height of wheat

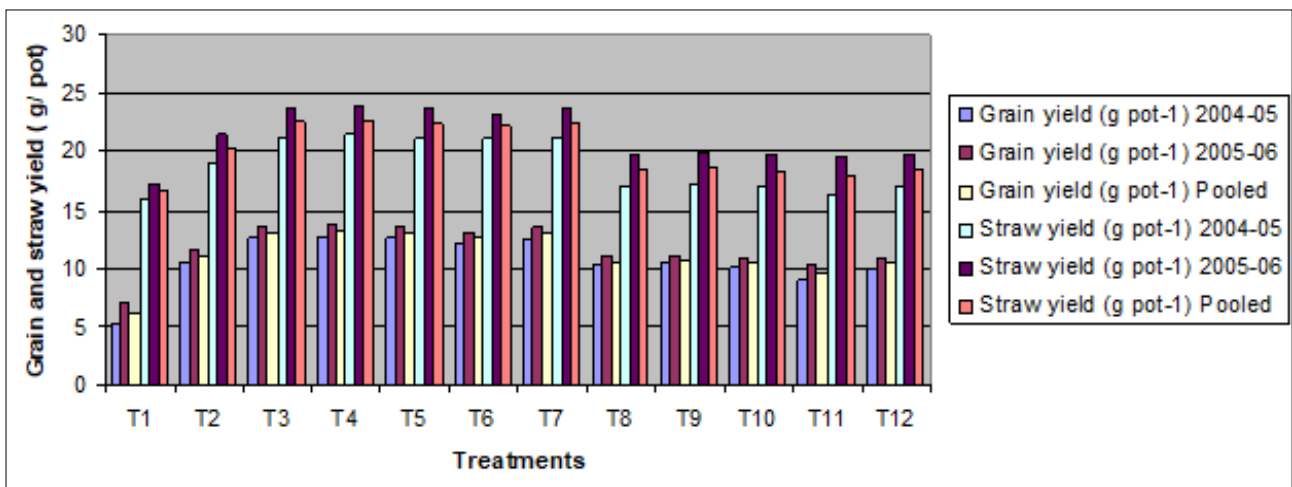


Fig 3: Effect of organic and inorganic sources of nutrients on yield of wheat

Recommendations

On the basis of only two years of pot experimentation, final recommendation for the farmers will not be justified. Nevertheless, the findings indicate that if recommended dose of N is to be applied through the organics (FYM, CW, PM, DS and PyM), there is a possibility of reduction in yield in comparison to recommended doses of chemical fertilizer along with 10 kg ha⁻¹ additional nitrogen through organic sources of nutrients and alone treatment of inorganic sources.

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Conclusion

Application of organic manures / wastes alone treatments was found to be favourable for pot experiment of wheat. Application of 100 per cent nitrogen through urea along with 10 kg N ha⁻¹ through carpet waste was found to be highly effective for achieving maximum yield of wheat in both years. The application of recommended doses of N through farm yard manure, poultry manure, press mud and carpet waste were also found suitable for nutrient acquisition to wheat as organic sources.

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