ISSN 1819-1894

Asian Journal of Agricultural Research

Knowledgia
SCIENTIFIC
A Place to Publish Outstanding Research

http://knowledgiascientific.com

Asian Journal of Agricultural Research 5 (1): 76-82, 2011
ISSN 1819-1894 / DOI: 10.3923/ajar.2011.76.82

Impact of Integrated Nutrient Management on Growth, Yield and Nutrient Uptake by Wheat (*Triticum aestivum* L.)

Chandra Mohan Singh, P.K. Sharma, Prem Kishor, P.K. Mishra, A.P. Singh, Rajhans Verma and P. Raha

Department of Soil Science and Agricultural Chemistry, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi-221005, UP, India

Corresponding Author: Chandra Mohan Singh, Department of Soil Science and Agricultural Chemistry, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi - 221005, UP, India

ABSTRACT

A field experiment was conducted during rabi season of 2005-06 at the Agricultural Research Farm, T.D. College Jaunpur, in randomized block design with three replications to assess the effect various types of organic and inorganic fertilizers on growth, yield attributes and NPK acquisition. The results revealed that growth attributes viz. number of tillers hill-1 and plant height significantly increased due to presence of nitrification inhibitors in nimco fertilizer, they slowly supplied nitrogen to plant and decreased the looses of nutrients resulting more nitrogen available to plant. Combined application of organic manures and inorganic fertilizers increased the dry matter accumulation, number of grains spike-1, grain yield, straw yield and NPK uptake by wheat crop compare to treatment T2 where full dose of NPK applied through urea, single superphosphate and murate of potash. Application of 50% N through nimco and 50% through Bhu amrit showed maximum number of tillers hill-1, plant height, number of grains spike-1, dry matter accumulation and test weight. The highest grain and straw yield of wheat to the extent of 44.9 and 69.56 q ha^{-1}, respectively was obtained where recommended dose of nitrogen was applied in ratio of ½:½: through nimco and Bhu amrit, respectively.

Key words: Ganga carbonic khad, Nimco, Bhu amrit, INM, nutrient uptake

INTRODUCTION

Wheat is the world's leading cereal crop cultivated over an area of about 226.45 m ha with a production of 161.9 m tonnes. In India, the wheat production is about 72 m tonnes from an area of around 25 m ha. Although, India is well placed in meeting its needs for food grains the major objective of food and nutritional security for its entire population has not been achieved. The demand for food grains is expected to rise not only as a function of population growth but also as more and more people cross the poverty line with economic and social development. The demand for wheat in India by 2020 has been projected to be between 105 to 109 m tonnes as against 72 m tonnes production of present day. Most of this increase in production will have to come from increased productivity, as the land area under wheat is not expected to expand. Efficient inputs management along with varietal improvement is the two basic aspects that can help us in achieving the target.

Wheat grains are comparatively better source of protein consumed in India. About 10-12% protein requirement is met by wheat. Maneuvering the application of different fertilizers could increase the productivity of the wheat crop and the protein content.

On account of continuing world energy crisis and spiraling price of chemical fertilizer, the use of organic manure as a renewable source of plant nutrients is assuming importance. In this endeavor proper blend of organic and inorganic fertilizer is important not only for increasing yield but also for sustaining soil health (Weber *et al.*, 2007: Larney and Hao, 2007; Pullicinoa *et al.*, 2009).

Compost amendments enhance SOM quality and quantity by an increased accumulation of various classes of organic compounds. Research on SOM following compost amendments has been mainly focused on changes of bulk organic carbon (Pedra *et al.*, 2007; Sebastia *et al.*, 2007), microbial biomass, macro and micronutrients availability (Kowaljow and Mazzarino, 2007) and organic matter pools such as Dissolved Organic Matter (DOM) and humic substances (Adani *et al.*, 2007). The integrated use of organic materials and inorganic nitrogenous fertilizers has received considerable attention in the past with a hope of meeting the farmer's economic need as well as maintaining favourable ecological conditions on long-term basis (Kumar *et al.*, 2007). The integrated nutrient management helps to restore and sustain fertility and crop productivity. It may also help to check the emerging deficiency of nutrients other than N, P and K. Further, it brings economy and efficiency in fertilizers. The integrated nutrient management favorably affects the physical, chemical and biological environment of soils. Integrated nutrient supply involving conjunctive use of fertilizers and organic sources of nutrients (Roy, 1992) assumes greater significance. Farmyard manure improves the physical condition of soil by increasing water holding capacity for maximum utilization of water. It also improves the chemical and biological condition of soil by increasing cation exchange capacity and providing various vitamins, hormones and organic acids which are very important for soil aggregation and for beneficial micro-organism which are involved in various biochemical processes and release of nutrients. Integration of FYM and inorganic N, productivity and monetary returns of wheat can be increased by maintaining or improving soil fertility (Sarma *et al.*, 2007). The combination of organic and inorganic N sources resulted in comparable rice yield to the application of inorganic N alone. Inorganic N application increased rice yield by 45.8 % over unfertilized control. The increase in yield was due to an increase in the number of panicle per plant and panicle weight (Rao *et al.*, 1996).

The recovery of nitrogenous fertilizers is generally low for most crops especially in Indian soils because of faster nitrification and volatilization. Using organic sources and nitrification inhibitors along with chemical fertilizer can minimize these losses. But the use of Neem cakes is limited and has not been fully exploited to increase the N use efficiency by reducing losses. Wheat is an important cereal crop and requires a good supply of nutrients especially nitrogen for its growth (Mandal *et al.*, 1992) and yield (Krylov and Pavlov, 1989). The studies pertaining to integrated use of organics and fertilizer along with neem cake (nitrification inhibitor) in wheat crop are few. There for, the present study was undertaken to determine the integrated use of organic manures and inorganic fertilizers on yield and nutrient uptake by wheat.

MATERIALS AND METHODS

Sampling and analysed of organic fertilizers: Organic Fertilizer (OF) was sampled from ten points in the bag and mixed well (approximately 20 kg-wet weight). Samples for analysis were collected from this Organic fertilizer mixture in three replications and analysed in Department of Agricultural Chemistry and Soil Science, T.D.P.G. College, Jaunpur, (UP) The organic fertilizer was digested with nitric-perchloric acid (9:1), di-acid mixture for the other elements except nitrogen. Nitrogen was determined by colorimetric method using Nessler's reagent and phosphorus was estimated by vanadomolybdate yellow colour method (Jackson, 1973). Potassium was estimated flame photometrically, respectively.

Table 1: Sources of nutrients and their nutrient contents

	Nutrient content (%)		
Source	N	P	K
Urea	46.0	0.00	0.00
SSP	0.0	16.00	0.00
KCl	0.0	0.00	58.00
Ganga carbonic khad	2.81	1.12	1.06
Bhu Amrit	3.21	1.62	1.18
Nimco	7.2	1.46	1.23

Field trial and treatments: A Field experiment was conducted during 15 November, 2005-06 at Agriculture Research Farm T.D.P.G. College, Jaunpur (UP) to test the influence of impact of integrated nutrient management on growth, yield and nutrient uptake by wheat (*Triticum aestivum* L.). Ten treatments were tested in randomized block design with three replications. Treatments included in the present study are detailed in Table 1.

Fertilizer nitrogen recommended on the basis of soil test for the region (120 kg ha^{-1}) was used to supply inorganic N (in the form of urea) and organic N in the form of Ganga carbonic khad, Bhu Amrit and Nimco or their combinations as per the treatments. The field soil used in the experiment was a dystic ustochrept having a pH of 7.6, electrical conductivity 0.30 d Sm^{-1} and organic C 4.5 g kg^{-1}. Available N, P_2O_5 and K_2O were 172, 12.85 and 113.25 kg ha^{-1}, respectively. Half of nitrogen and the total quantity of phosphorus and potash were incorporated in field during wheat sowing and full dose of organic sources as per treatment combination were incorporated in field before 15 days of wheat sowing. Remaining 60 kg N ha^{-1} was applied in two equal splits at tillering and flag leaf initiation stages respectively. Wheat seeds (variety HUW 510) were sown in field as per treatment. The recommended agronomic practices were adopted for raising the crop.

Growth attributes and yields of wheat: Yield attributing characters such as number of tillers per hill, plant height (cm), number of grains per spike, test weight (g) and dry matter production (q ha^{-1}) were measured at 30 and 60 days by destructive sampling of field. Crop was harvested at maturity and grain and straw yield was recorded.

Plant analyses: Wheat grains and straw were air dried and stored at room temperature for 3 months prior to analysis. Nitrogen was analysed using the standard Kjeldahl method. The analysis of the rest of the elements the samples were digested in a tri acid digestion mixture (HNO_3: $HClO_4$: H_2SO_4: 9:4:1). Phosphorus content was estimated as described by Taussky and Shorr (1953) and potassium content was determined by flame photometry.

Statistical analysis: All of the plant data were analyzed by Randomized Block Design, using Microsoft Excel and SPSS packages. Least Significance Difference (LSD) at p = 0:05 were tested to determine the significant difference (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

Total number of tillers and plant height (cm) pertaining to different treatments recorded at 30 and 60 days after sowing has been presented in Table 2. Scanning of data revealed that the total number of tillers hill^{-1} ranged from 4.4 to 5.8 and 6.1 to 8.5 at 30 and 60 days, respectively. The

Table 2: Effect of conjunctive use of organic manures and inorganic fertilizers on growth

Treatments	Average No. of tillers hill^{-1}		Average height of plants (cm)		Dry matter production (q ha^{-1})		No. of grains spike^{-1}	Test weight (g 1000^{-1} seeds)
	30	60	30	60	30	60		
T_1	4.4	6.1	24.75	47.4	22.6	62.7	24.3	30.35
T_2	5.2	6.9	32.28	55.2	35.4	84.8	27.7	34.92
T_3	5.4	7.6	33.43	58.8	41.6	91.3	34.9	36.95
T_4	5.5	7.8	33.66	59.4	43.7	93.4	36.7	37.49
T_5	5.3	7.4	33.20	57.4	39.8	89.6	32.8	36.23
T_6	5.7	8.3	34.23	59.8	47.6	97.9	40.5	38.30
T_7	5.8	8.5	34.28	60.5	49.9	99.7	42.4	39.83
T_8	5.0	6.8	32.00	54.6	33.6	77.1	26.5	34.70
T_9	5.1	7.2	32.98	56.7	37.5	87.5	29.7	35.65
T_{10}	5.6	8.0	34.10	59.6	45.8	95.8	38.2	37.89
CD at 5% level	0.52	0.38	0.57	2.17	3.92	4.32	2.53	1.16

Attributes of wheat at 30 DAS and 60 DAS

enhancement in tiller number and plant height with increase in nitrogen use efficiency is attributed to the rapid conversion of synthesized carbohydrates into protein and consequent to increase in the number and size of growing cells, resulting ultimately in increased number of tillers (Singh and Agarwal, 2001).

Treatment T7gave significantly greater number of tillers hill^{-1} and plant height than T1, T2, T8 and T9 at 30 and 60 days, where recommended dose of nitrogen was applied in the ration 1/2:1/2 through N-nimco and Bhu amrit. Treatment T7 gave insignificantly higher number of tiller hill^{-1} and plant height than T6. Treatment T7 gave significantly higher drymatter accumulation, number of grains per spike and test weight of wheat crop were significantly higher compare to treatment T1, T2, T8 and T9. This is due to application of N through nimco is probably due to enhanced availability of nitrogen which enhanced more leaf area resulting in a higher photo-assimilates and there by resulted in more dry matter accumulation. As similar result was observed by Andrew *et al.* (1968). Application of 100% N through urea resulted in significant reduction in number of tillers hill^{-1}, plant height, dry matter accumulation, number of grains spike^{-1} and test weight (g) of wheat plant compare to all other treatments except T1, where no addition of nutrients (Table 2). Higher growth and yields of wheat was recorded with 50% N through N-nimco +50% N through Bhu amrit . All the growth attributes i.e., number of tiller number hill^{-1}, plant height, dry matter accumulation, number of grains spike^{-1} and test weight were significantly affected by the application different sources of organic manures and inorganic fertilizers.

There is highly significant difference among nitrogen sources for number of grains per spike. Maximum number of grains per spike (42.4) was recorded in T_7 while minimum number of grains per spike (24.3) was observed in control (Table 2). This trend might be due to the role of nitrogen in crop maturation, flowering and fruiting, including seed formation. These results are accordance with those of Thakur *et al.* (1981).

The wheat yield revealed that the crop responded significantly to combined application of organic manure and inorganic fertilizers as compared to control (Table 3). It was found that application of nitrogen improves various crop parameters like 1000-grain weight (Krylov and Pavlov, 1989) and more productive tillers (Wilhelm, 1998) thus resulting in higher grain yields.

Table 3: Effect of conjunctive use of organic manures and inorganic fertilizers on grain and straw yield (q ha^{-1}) of wheat

Treatments	Grain yield	Straw yield
T_1	27.50	41.25
T_2	40.80	56.20
T_3	42.00	63.00
T_4	43.30	66.20
T_5	41.80	62.70
T_6	43.68	66.39
T_7	44.90	69.56
T_8	38.00	55.70
T_9	39.50	59.25
T_{10}	43.45	66.25
CD at 5% level	1.89	2.79

Table 4: Effect of conjunctive use of organic manures and inorganic fertilizers on nutrient uptake (kg ha^{-1}) by grain and straw

	Grain			Straw		
Treatments	N	P	K	N	P	K
T_1	48.67	8.91	17.87	27.23	3.26	39.18
T_2	73.44	17.74	30.60	46.51	6.36	57.32
T_3	77.70	18.64	32.59	51.66	7.25	73.71
T_4	79.00	19.09	32.82	56.81	8.08	79.44
T_5	76.91	18.39	32.39	50.79	6.71	70.85
T_6	82.99	20.00	34.28	57.76	9.23	83.65
T_7	85.59	20.59	35.03	61.91	10.43	89.03
T_8	68.02	12.50	28.50	43.85	4.96	54.02
T_9	71.89	17.26	30.41	46.81	5.81	65.17
T_{10}	81.40	19.70	33.90	56.31	8.61	81.49
CD at 5% level	0.42	0.79	0.86	0.76	0.29	1.28

Straw yield was also significantly affected with combined application of organic manures and inorganic fertilizers (Table 3). The highest straw yield (69.56 q ha^{-1}) was observed in T_7, followed by T_6 (66.39 q ha^{-1}). Application of nitrogen significantly increased the N, P and K uptakes of wheat in different treatments in comparison to control (Table 4). Application of 120 kg N ha^{-1} through nimco + bhu amrit significantly increased N, P and K uptakes of wheat by 85.59, 20.59 and 35.03 kg ha^{-1}, respectively over control. The increased uptake of the nutrients was due to added supply of nutrient and well developed root system resulting in better absorption of water and nutrient. These results are in consonance with the findings of Datt *et al.* (2003). The increase in growth and yield owing to the application of N-fertilizer may be attributed to the fact that this nutrient being important constituents of nucleotides, proteins, chlorophyll and enzymes, involves in various metabolic processes which have direct impact on vegetative and reproductive phase of plants. These findings confirm those of Mengel and Kirkby (1996).

CONCLUSION

Based on the findings of the present investigations, it can be inferred that the application of 120 kg N ha^{-1} through nimco + bhu amrit proved effective in significantly enhancing the growth attributes. Nutrients supplied through inorganic sources was not as effective as that from inorganic + organic sources along with neem cake. So wheat crop need to be integrated with organic sources of N and nitrification inhibitor in conjunction with inorganic fertilizers for higher yield and nutrient uptake. Thus, it may be concluded that the management of N plays a significant role in optimizing wheat production.

REFERENCES

Adani, F., P. Genevini, G. Ricca, F. Tambone and E. Montoneri, 2007. Modification of soil humic matter after 4 years of compost application. Waste Manage., 27: 319-324.

Andrew, H.N., V.N. Hardy and T.H. Robins, 1968. Growth and yield of wheat as influenced by levels of nitrogen, sulpher and zinc. Aust. J. Agric. Res., 30: 155-165.

Datt, N., R.P. Sharma and G.D. Sharma, 2003. Effect of supplementary use of farmyard manure along with chemical fertilizers on productivity and nutrient uptake by vegetable pea and nutrient build up to soil fertility in Lahual valley of Himachal Pradesh. Indian J. Agric. Sci., 73: 266-268.

Gomez, K.A. and A.A. Gomez, 1984. Statistical Procedure for Agricultural Research. 1st Edn., John Wiley and Sons, New York, pp: 28-291.

Jackson, M.L., 1973. Soil Chemical Analysis. Prentice Hall of India Pvt. Ltd., New Delhi, India.

Kowaljow, E. and M.J. Mazzarino, 2007. Soil restoration in semiarid Patagonia: Chemical and biological response to different compost quality. Soil Biol. Biochem., 39: 1580-1588.

Krylov, Y.A.I. and V.D. Pavlov, 1989. Effect of fertilizer on yield and protein contents in wheat grain. Agrochimiya, 1: 49-51.

Kumar, A., H.P. Tripathi and D.S. Yadav, 2007. Correcting nutrient for sustainable crop production. Indian J. Fert., 2: 37-44.

Larney, F.J. and X. Hao, 2007. A review of composting as a management alternative for beef cattle feedlot manure in southern Alberta, Canada. Bioresour. Technol., 98: 3221-3227.

Mandal, N.N., P.P. Chaudhry and D. Sinha, 1992. Nitrogen, nitrogen and potash uptake of wheat (var.Sonalika). Environ. Econ., 10: 297-297.

Mengel, K. and E.A. Kirkby, 1996. Principles of Plant Nutrition. 4th Edn., Panina Publishing Corpporation, New Delhi, India, pp: 147-149.

Pedra, F., A. Polo, A. Ribeiro and H. Domingues, 2007. Effects of municipal solid waste compost and sewage sludge on mineralization of soil organic matter. Soil Biol. Biochem., 39,: 1375-1382.

Pullicinoa, D.S., L. Massaccesia, L. Dixonb, R. Bolb and G. Gigliottia, 2009. Organic matter dynamics in a compost-amended anthropogenic landfill capping-soil. Eur. J. Soil Sci., 61: 35-47.

Rao, K.S., B.T.S. Moorthy and C.R. Padalia, 1996. Efficient nitrogen management for sustained productivity in lowland rice (*Oryza sativa*). Indian J. Agron., 41: 215-220.

Roy, R.N., 1992. Integrated Plant Nutrition System. An overview. In: Fertilizers, Organic Manure, Recyclable Wastes and Bio-Fertilizers, Tandon, H.L.S. (Ed.). Fertilizer Development and Consultation Orgnization, New Delhi.

Sarma, A., S. Harbir and R.K. Nanwal, 2007. Effect of integrated nutrient management on productivity of wheat (*Triticum aestivum*) under limited and adequate irrigation supplies. Indian J. Agron., 52: 583-586.

Sebastia, J., J. Labanowski and I. Lamy, 2007. Changes in soil organic matter chemical properties after organic amendments. Chemosphere, 68: 1245-1253.

Singh, R. and S.K. Agarwal, 2001. Analysis of growth and productivity of wheat (*Triticum aestivum* L.) in relation to levels of FYM and nitrogen. Indian J. Plant Physiol., 6: 279-283.

Taussky, H.H. and E. Shorr, 1953. A microcolorimetric method for the determination of inorganic phosphorus. J. Biol. Chem., 202: 675-682.

Thakur, M.P., P.R. Patel, R.A. Behera and M.A. Sinha, 1981. Influence of NPK on growth yield and quality of wheat (*Triticum aestivum* L.). Effect of different levels of nitrogen and phosphorous on yield quality of wheat. J. Maharashtra Agric. Univ., 18: 310-311.

Weber, J., A. Karczewska, J. Drozd, M. Licznar, S. Licznar and E. Jamroz, 2007. Agricultural and ecological aspects of a sandy soil as affected by the application of municipal solid waste composts. Soil Biol. Biochem., 39: 1294-1302.

Wilhelm, W.W., 1998. Dry matter partitioning and leaf area of winter wheat growth in a long term fallow tillage comparisons in U.S. Central Great Plans. Soil Tillage Res., 49: 49-56.