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Effect of fertility, zinc and cow urine levels on yield and soil parameters of wheat and their residual effect on succeeding fodder maize under dairy based integrated farming system of Varanasi tract

Sunita Choudhary, JS Bohra, Malchand Jat, Basant Kumar Dadrwal and Dr. Vinay Pratap Singh

Abstract
The field study was executed in two successive years of 2016-17 and 2017-18 at the Agricultural Research Farm, Banaras Hindu University, Varanasi (U.P.) to assess the effect of cow urine application at varying fertility and zinc levels on growth and yield of wheat (*Triticum aestivum* L.) and their residual effect on fodder maize under irrigated condition of Varanasi. Results revealed that the 100% RDF applied to preceding wheat recorded significantly maximum grain yield, straw yield, gross returns, net returns and B: C ratio of wheat as well as green and dry fodder yield and net returns of succeeding fodder maize over 75% RDF during both the years of study. Similarly, the application of zinc at 10 kg ha^{-1} recorded significantly maximum values of above parameters in wheat except B: C ratio and in fodder maize at 70 DAS. Nevertheless, it being at par with 5 kg Zn ha^{-1} both produced significantly higher value of above parameters over control. Increasing levels of cow urine application distinctly improved grain as well as straw yield and the each successive increment in cow urine level from 0-12000 l ha^{-1} significantly enhanced grain and straw yield of wheat during both the years of study however with respect to gross returns and net returns it being at par with 8000 l (U_1) cow urine ha^{-1}, both proved significantly superior over control. With respect to B: C ratio highest value was obtained with U_0 which being at par with U_1 significantly higher than U_2 during first year. However, in the second year all the treatments differ significantly with each other. Various cow urine levels applied in preceding wheat crop were not exerting any residual effect on growth, yield and economics of maize. Soil parameters *viz.* soil pH, soil EC, soil organic carbon, soil bulk density, available N, P, K and Zn after harvesting of wheat and fodder maize were not affected significantly due to various fertility, zinc and cow urine levels.

Keywords: Cow urine, fertility, SPAD, wheat, yield, zinc

1. Introduction
Worldwide, wheat (*Triticum aestivum* L) is the widely grown staple food crop and a high-priority food in more than 40 countries. It leads in area (220.06 m ha) in the world, stands second in production (763.2 m t) after maize and third in the productivity (3.49 t ha^{-1}) after maize and rice. Wheat contributes nearly 35 per cent to the world's food grain production and supplementing about 55% carbohydrates and 20% food calories. Its nutritional profile is better than the other cereals. Among the countries, India occupies the highest wheat growing area (30.79 m ha) and ranks second in production (98.51 m t) after china (USDA, 2019) [34], contributes 15.36% to the world wheat production. In India, it is the second major staple cereal crop after rice, contributes significantly to food and nutrition security by meeting 20 % of proteins and 19 % calorie intake. Uttar Pradesh, among the states, occupied highest wheat growing area (9.66 m ha, 31.56 % to all India) and production (30.06 m t, 30.55 % to all India) despite its low productivity (3113 kg ha^{-1}) than Punjab (4704 kg ha^{-1}) and Haryana (4514 kg ha^{-1}) (Agri. statistics at a glance, 2017). India has also lower wheat productivity (3216 kg ha^{-1}) than the world average (3470 kg ha^{-1}). The continuous indiscriminate and irrational use of chemical fertilizers leads soil health towards deterioration in entire Indo-Gangetic alluvial belt of India where the exhaustive rice-wheat system is dominant. Besides this, the cost of chemical fertilizers is continuously increasing due to increasing world energy crisis. Thus, the renewable sources of plant nutrient such as organic manures are getting important in wheat cultivation. Also, proper blend of organic sources and inorganic fertilizer not only increases productivity but also sustain soil health.

At the same time, organic sources are bulky in nature having low nutrient content and high volume which increase their transportation cost and limited availability restrict their widespread use. So, the above issues related to nutrient availability shift our emphasis towards integrated nutrient management (INM) system, which plays an important role in sustaining soil health and crop production. Among different organic sources, cow urine is the byproduct of livestock production which is adequately available to farm household under integrated farming system and its use in crop production is ecofriendly without any adverse effect on crops, human health and ecosystem. In addition, it does not have the problem of the slow release of nutrients like other organic sources which affects crop growth and can be sprayed at critical growth stage of crop. Apart from this, cow urine, being organic in nature has been reported to improve soil structure, working as a plant hormone, correct the micronutrient deficiency and increase the fertilizer use efficiency. The concentration of total nitrogen in cow urine vary from 6.8-21.1 g N/litre in which urea constitute 69%, hippuric acid 5.8%, allantoin 7.3%, creatine 2.5%, creatinine 3.7%, uric acid 1.3% and xanthin plus hypoxanthin 0.5%, ammonia 2.8% and free amino acid nitrogen 1.3% (Bristow *et al*., 1992) [4]. It constitutes 95% water, 2.5% urea and the rest 2.5% is a combination of hormones, minerals (phosphate, potassium, sulphur, sodium, manganese, iron, silicon, chlorine etc.), enzymes and salts (carbolic acid etc.) thus, it can be seen that cow's urine is not a toxic effluent (Kishore *et al*., 2015) [12]. Besides urea, cow urine also contains different type of inorganic compounds including silver, Na-K ratio of 4:1 (36%:9% in dried urine). In fresh cow urine, per 100 ml, 50-100 mg oestrogens; 20-200 µg of cortico-steroids and 0.05-0.15 mg of 17-keto-steroids are also reported (Vasanthi and Venkatalakshmi, 2015) [35]. Nitrogen in the urine which is mainly in the form of urea can be subjected to volatilization losses, if urine is not conserved. Favorable effect of cow urine application has been reported in enhancing the productivity of different crops *viz.* wheat (Abraham *et al*., 2004) [1], (Sadhukhan *et al*., 2018a) [24], maize (Devakumar *et al*., 2014) [5], mustard (Pradhan *et al*., 2015) [20], (Pradhan *et al*., 2016) [21] and rice (Sadhukhan *et al*., 2017) [23], (Sadhukhan *et al*., 2018c) [25], (Sadhukhan *et al*., 2018b) [26], (Sadhukhan *et al*., 2019) [27] and (Sahare and Mahapatra, 2015) [28].

Currently, zinc deficiency in Indian soils has been the most widespread micronutrient deficiency and it comes next to N and P (nearly 50% soils in north India are low in Zn) which affects crop yield and quality severely (Sharma *et al*., 2016) [31]. It is observed from research trials that the residual effect of organic and inorganic nutrients is exploited; it can reduce the cost on nutrient application of succeeding crop. Generally leftover nutrient status of previous season crop or cropping system is not considered in recommending nutrient management and direct nutrient management is done to the next season individual crop or cropping system. Besides this, as compared to the individual crop, a cropping system is more efficient due to the huge residual nutrients left by previous crop and the succeeding crop utilizing this residual effect. Within view, the fodder maize crop was taken in succeeding summer season with 50% NPK application to examine the residual effect of treatments given to preceding wheat crop, if any. Estimates of residual nutrient status of soil helps in assessments of nutrient balance sheets both for a particular field as well as geographical regions. The nutrient status of the soil depends on balance between influx and replenishment of nutrient ions and the extent of their depletion, which is related to intensity and capacity of soil solid phase and soil solution. The difference in residual nutrient status of the soil is due to variations in nutrient uptake by the plants. Apart from applied nutrient, plants can also make use of inherent soil fertility. Therefore, the current investigation was executed to evaluate the impact of cow urine as a potential organic fertilizer source in crop production under integrated farming system involving livestock along with fertility and zinc levels.

Green fodder is an important component of animal husbandry. The growth of dairy sector primarily depends upon the availability of nutritious fodder. Maize is one of the most nutritious non-legume green fodders. The high acceptability of maize as fodder can be judged from the fact that it is free from any anti-nutritional components.

Maize is quick growing, yields high biomass, and is highly palatable. It contains sufficient quantities of protein and minerals and possesses high digestibility as compared to other non-legume fodders. It contains high concentrations of soluble sugars in the green stage, which makes it most fit for preservation as silage. The abundance of green fodder due to increasing cultivation of specialty corn could greatly help in boosting the prospects of dairy sector in the peri-urban regions of the country Green fodder is an important component of animal husbandry. The growth of dairy sector primarily depends upon the availability of nutritious fodder. Maize is one of the most nutritious non-legume green fodders. The high acceptability of maize as fodder can be judged from the fact that it is free from any anti-nutritional components.

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Livestock sector in India with a growth rate of 4.82% plays an important role in Indian economy, provides livelihood to about 20.5 million people (nearly two-third of rural community). Besides this, it contributes, 4.11% to GDP and 25.6% to total agriculture GDP. This vast sector contributed 16% to the income of small farm households whereas 14% for all rural households and about 8.8 % of the population in India receives employment. The growth of dairy sector primarily improved through availability of nutritious fodder. As the forage supply in India is short both as quantity and quality. Currently, fodder is cultivated on 8.6 million hectare land which is nearly 4.5% of total cultivated area in the country. This acreage is remained constant over years as competition between various land uses for the cultivable land is also increasing. According to present forage resource growth, country faces 65% green fodder and 25% dry fodder deficiency. The alluvial soils of Uttar Pradesh, Bihar and Punjab are suitable for raising maize crop.

Maize is non-leguminous quick biomass carrying, nutritious, succulent and highly palatable fodder crop with high content of protein and minerals and better digestibility and can be grown year round under irrigated conditions. Fodder maize is cultivated on nearly 0.9 million ha area in different parts of the country. It is an excellent crop for silage as its green fodder is full of soluble sugars besides can be feed as green or dry fodder. In terms of quality, it is free from any antiquality constituent unlike sorghum and pearl millet, having hydrocyanic acid and oxalate, respectively affecting animal health adversely. Based on dry matter at milking to early dough stage, it contains nearly 9-10% crude protein (CP), 60-64% neutral detergent fiber (NDF), 38-41% acid detergent fiber (ADF), 23-25% hemicellulose, and 28-30% cellulose. Thus, forage maize constituting major part of ruminant rations currently because of its better forage intake and animal performance besides lower production costs.

2. Materials and Methods

The field study was carried out at the Agricultural Research Farm, Banaras Hindu University, and Varanasi (U.P.) in two successive years of 2016-17 and 2017-18. The investigation was started from *rabi* 2016-17 (Dec.-April), continued through the summer season in 2017 (May-July) to the *rabi* season in 2017-18 (Nov.-April) and Summer season in 2017-18. The experiment was performed in split plot design with combinations of 2 fertility levels (100% RDF and 75% RDF) and three zinc levels (0, 5 and 10 kg Zn ha^{-1}) in main plots and 3 cow urine levels (U_2 - 12000 l ha^{-1} equally distributed at sowing, CRI, and spike emergence, U_1 - 8000 l ha^{-1} equally applied at sowing and CRI and U_0 - 0 l ha^{-1}) in sub-plots and all the 18 treatment combinations replicated thrice. The soil of the experimental site was slightly alkaline (pH- 7.35) having low organic carbon (0.35%) and available nitrogen (203.49 kg ha^{-1}) and medium available phosphorus (17.77 kg ha^{-1}) and potassium (192.21 kg ha^{-1}). The DTPA-Extractable soil available Zn was 1.03 mg Kg^{-1} of soil. The Bulk density (g cc^{-1}) of 0-30 cm depth and Soil electrical conductivity (1:2 Soil:Water suspension) (dSm^{-1}) at 25ºC were 1.41 and 0.25, respectively. The nutrient sources, Urea, DAP, MOP and $ZnSO_4.H_2O$ were utilized for application of the nutrients *viz*. N, P, K and Zn as per treatment, respectively in wheat. Full recommended doses of P, K, Zn and half of nitrogen were applied as basal and remaining half dose of nitrogen was top dressed through urea in two equal splits at CRI and spike emergence stages. The cow urine without any mixture was collected from cattle shed of IFS model of the Institute of Agricultural Sciences, BHU, Varanasi and stored in plastic cans.

Table 1: Nutrient content and pH in the cow urine sample before starting the experiment.

N (%)	P (%)	K (%)	Ca (%)	Mg (%)	S (%)	pH
1.01	0.094	1.12	0.014	0.13	0.081	7.8

The analysis of the cow urine for the nutrient contents and pH was done in the laboratory before starting the experiment (Values given in Table 1). The cow urine was applied in wheat as per treatment with watering can in the furrow at the time of sowing as basal application and towards the root zone between two rows at CRI and spike emergence stages. Variety "HD 2967" of wheat was sown at the seed rate of 100 kg ha^{-1} during the first week of December at 22.5 cm row spacing with the help of *Kudal*. The crop was irrigated according to the crop need mainly at the critical stages and the required plant protection measures were adopted. Similarly, all other recommended package of practices was followed.

This same layout was used for residual fodder maize crop in summer after the harvesting of wheat. Individual plots were prepared after a pre sowing irrigation by using power tiller without disturbing the initial layout of the field. Fodder maize variety "African Tall" was sown at the seed rate of 40 kg ha^{-1} during middle of April at 30 cm row spacing with *kudal*. After the harvesting of wheat, fodder maize was taken as residual crop and in all the plots nutrients were applied at 50% RDF (40, 15, 15 kg ha^{-1} NPK). Half of the N and full dose of P and K were applied as basal and rest 50% N was top dressed in two equal splits at 25 DAS and 55 DAS. The fodder maize crop was harvested at 72 days after sowing. At first, the border rows were harvested with the help of sickle and separated. Later, crop from each net plot was harvested. Soil samples were collected from 0-15 cm depth for assessing the initial physico-chemical properties just before sowing and after harvesting of wheat and succeeding fodder maize. These samples were carefully oven dried in shed on polythene sheet followed by grounded and sieved through a 2 mm mesh. The estimation of soil parameters *viz*. soil bulk density, soil electrical conductivity and soil pH, soil organic carbon, available nitrogen in soil, available phosphorus in soil, available potassium in soil and available Zn was done by the methods described by Piper (1966) [19], Jackson (1973) [10], Walkley and Black's method (1934), Subhiah and Asija (1956) [33], Olsen *et al*. (1954) [16], Jackson (1973) [10] and Lindsay and Norvell (1978) [15], respectively. The economics of different treatments were calculated separately by taking into account the existing price of inputs and produce for both the years. The data were analyzed by the standard procedure for analysis of variance as described by (Gomez and Gomez, 1984).

3. Results and Discussion

3.1 Yield

3.1.1 Wheat

Various fertility levels distinctly improved grain and straw yield of wheat during both the years of investigation. The 100% RDF increased 9.84 and 9.83% grain yield and 9.54% and 9.01% straw yield of wheat over 75% RDF during 2016-17 and 2017-18, respectively. Adequate and balanced fertilization at higher fertility levels might have improved grain and straw yields of wheat due to increased availability and assimilation of major nutrients that assist in higher dry matter production resulting into improved source and sink relationship and production of favorable growth and yield components which finally increased yield. These findings are similar to the findings of Samimi and Thomas (2016). Similarly, zinc application at the rate of 10 kg Zn ha^{-1} being at par with 5 kg Zn ha^{-1} gave significantly higher grain as well as straw yield over control. This yield increment might be due to the beneficial effect of zinc on the growth parameters of wheat which also promoted yield attributes, finally contributed to yield. These results are in line to those of Ahmadi and David (2016) [3]. Likewise, an increment of 13.05 and 8.25% in the first year and 11.45% and 8.07% in the second year were obtained with application of 12000 and 8000 l ha^{-1} cow urine, respectively, as compared to control. This could be due to increased growth parameters at higher cow urine doses which resulted into higher yield attributes *viz*. number of spikes, spike length and number of grain spike^{-1}, finally contributed to increased grain and straw yield. The results are in line to those of Devakumar *et al*. (2014) [5] in maize and Sadhukhan *et al*. (2018a) [24] in wheat.

3.1.2 Fodder Maize

Yield data showed that the residual effect of 100% RDF significantly increased green and dry fodder yield over 75% RDF. The increment in green and dry fodder yield of fodder maize in response to residual effect of fertility levels might be ascribed to its impact on better growth attributing characters *viz*. plant height and number of leaf plant^{-1}. This might have resulted in the synthesis of higher amount of photosynthates on larger surface area available for the activity leading thereby enhanced dry matter accumulation as well as the green and dry fodder yield. The results of the present study are in accordance with the findings of (Devi and Singh, 2006) [6], (Kaushik *et al*., 2013) [11] and (Rajput *et al*., 2007) [22].

Similarly, distinct improvement in green and dry fodder yield of succeeding fodder maize crop was noticed due to residual effect of zinc levels applied to preceding wheat crop. The trend of the production of green and dry fodder yield was 10 kg Zn ha^{-1}>5 kg Zn ha^{-1}>control. Notwithstanding, residual effect of 10 kg Zn ha^{-1} and 5 kg Zn ha^{-1}, though, remained at par both produced significantly higher green and dry fodder yield over control. The sufficient nutrient availability with the application of increasing zinc levels in the soil to preceding wheat might have supported the growth parameters of the crop such as plant height and number of green leaf plant^{-1} which finally improved the green and dry fodder yield of succeeding fodder maize. These findings are in agreement with the results of the earlier workers *viz*. (Devi and Singh, 2006) [6] and (Kumar and Qureshi, 2012) [14].

Although, the green and dry fodder yield of maize, though, improved with increasing levels of cow urine from 0-12000 l ha^{-1} applied to preceding wheat during both the years. However, the differences remained comparable. Looking at the residual effect of cow urine on the growth parameters *viz*. plant height and number of green leaf plant^{-1} such result is obvious.

3.2 Soil Parameters

3.3.1 Wheat

The increasing levels of fertility, zinc and cow urine, though, improved physico-chemical properties of soil *viz*. pH, EC and organic carbon as well as available N, P, K and Zn in soil after harvesting of wheat, the differences were not significant. Moreover, no definite trend could be established with respect to soil bulk density after wheat harvest. Available N, P and Zn in soil were marginally increased as compared to initial values; whereas, available K was slightly decreased than its initial status during both the years of investigation. This might be due to the fact that potassium application was not given much importance until 1980's in India because of common faith that potassium in soils were in plenty and also profitable response was not always recognized of applied K thus low blanket applications were permitted (Ghosh and Hasan, 1976) [8]. Also, N, P and K applications over time in India showed that much lower dose of K fertilizers was applied in imbalanced form and following exhaustive rice-wheat sequence in Indo-Gangetic region since long, the soil reserve of K has exhausted in most areas.

3.3.2 Fodder Maize

The residual effect of fertility, zinc and cow urine levels did not affect the physico-chemical properties of soil *viz*. pH, EC, organic carbon and bulk density and nutrient status *viz*. available N, P, K and Zn in soil after succeeding fodder maize harvest during both the years of investigation. However, the above parameters obtained maximum with the residual effect of higher doses of cow urine levels except bulk density which did not show any definite trend.

3.3 Economics

3.3.1 Wheat

Fertility levels increasing from 75% to 100% RDF significantly increased the net returns and benefit cost ratio which indicated that application of 100% RDF in wheat was more beneficial over 75% RDF. Also, maximum gross and net returns in wheat were obtained with 10 kg Zn ha^{-1} which remained at par with 5 kg Zn ha^{-1}. However, the benefit cost ratio was not significantly differed. Hence, it is concluded that, however, the differences among zinc application at 5 and 10 kg ha^{-1} were not significant but the maximum net returns was obtained at 10 kg Zn ha^{-1} during both the years. The data regarding cow urine application revealed that 12000 l cow urine ha^{-1} gave the maximum gross returns but the 8000 l ha^{-1} cow urine gave the maximum net returns during both the years. Nonetheless, the differences were not at the level of significance. Thus, it is concluded that cow urine application at 8000 l ha^{-1} was more remunerative. The benefit cost ratio was decreasing with increasing cow urine levels, the maximum with control followed by 8000 l cow urine ha^{-1}, both being at par but significantly higher than 12000 l cow urine ha^{-1}. This might be due to increasing cost of application of cow urine with higher doses of cow urine.

3.3.2 Fodder Maize

The economic viability of the residual effect of treatments applied in preceding wheat accompanied with the expenses involved in the cultivation of succeeding maize fodder was worked out in terms of cost of cultivation, gross returns, net returns and benefit cost ratio (Table 5). The residual effect of 100% RDF distinctly improved the net return and benefit cost ratio over 75% RDF. This indicated that residual effect of 100% RDF in wheat was quite more profitable in terms of green and dry fodder yield over 75% RDF. In case of residual effect of zinc levels, 10 kg Zn ha^{-1} applied to wheat recorded maximum gross returns, net returns and benefit cost ratio in succeeding fodder maize which remained comparable with 5 kg Zn ha^{-1}, however, it was significantly higher over control. Therefore, it could be seen that residual zinc gave remunerative returns up to application of 10 kg Zn ha^{-1}. Further, increasing levels of cow urine from 0 to 120000 l ha^{-1} applied to preceding wheat, though, improved the gross returns, net returns and benefit cost ratio of succeeding fodder maize but the differences remained at par during both the years, indicating that the residual effect of cow urine on succeeding maize fodder was not significant. Nevertheless, due to its low cost, its application was remunerative even to the succeeding maize fodder.

Table 2: Effect of varying levels of fertility, zinc and cow urine application on grain and straw yield of wheat.

Treatments	Grain yield (kg ha^{-1})		Straw yield (kg ha^{-1})		Harvest index (%)	
	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18
Main plot Fertility level						
F_1- 100% RDF	4813	4916	7142	7244	40.30	40.47
F_2- 75% RDF	4382	4476	6520	6645	40.15	40.22
SEm±	62	49	113	112	0.54	0.50
CD 5%	194	154	355	354	NS	NS
Zinc level (kg Zn ha^{-1})						
Zn_0- 0	4353	4456	6501	6607	40.03	40.23
Zn_1- 5	4662	4744	6958	7041	40.17	40.30
Zn_2- 10	4777	4888	7033	7185	40.47	40.51
SEm±	75	60	138	138	0.66	0.62
CD 5%	237	189	435	433	NS	NS
Sub plot Cow urine (l ha^{-1})						
U_0- 0 (Control)	4292	4409	6494	6601	39.79	40.06
U_1-4000 each at Sowing and CRI	4730	4815	6979	7098	40.40	40.43
U_2-4000 each at Sowing, CRI and SE	4770	4864	7020	7133	40.49	40.54
SEm±	56	48	66	65	0.40	0.33
CD 5%	162	141	192	189	NS	NS

Table 3: Effect of varying levels of fertility, zinc and cow urine application on economics of wheat.

Treatments	Cost of cultivation (` ha^{-1})		Gross return (` ha^{-1})		Net return (` ha^{-1})		B:C	
	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18
Main plot Fertility level								
F_1- 100% RDF	47760	47760	122342	124195	74582	76435	1.56	1.60
F_2- 75% RDF	45779	45779	111469	113170	65689	67391	1.44	1.48
SEm±	–	–	1199	978	1199	978	0.03	0.02
CD 5%	–	–	3777	3081	3777	3081	0.08	0.07
Zinc level (kg Zn ha^{-1})								
Zn_0- 0	45324	45324	110863	112711	65539	67387	1.45	1.49
Zn_1- 5	46770	46770	118708	120180	71938	73410	1.54	1.58
Zn_2- 10	48215	48215	121145	123156	72930	74941	1.51	1.56
SEm±	–	–	1468	1197	1468	1197	0.03	0.03
CD 5%	–	–	4625	3773	4625	3773	NS	NS
Sub plot Cow urine (l ha^{-1})								
U_0- 0 (Control)	42706	42706	109718	111822	67012	69116	1.57	1.62
U_1-4000 each at Sowing and CRI	47582	47582	119448	120988	71865	73406	1.51	1.54
U_2-4000 each at Sowing, CRI and SE	50020	50020	121550	123237	71530	73217	1.43	1.46
SEm±	–	–	1034	938	1034	938	0.02	0.02
CD 5%	–	–	3017	2737	3017	2737	0.07	0.06

Table 4: Effect of varying levels of fertility, zinc and cow urine application on physico-chemical properties of soil after harvesting of wheat.

Treatments	Soil pH		Soil EC (dS m^{-1})		Soil organic carbon (%)		Soil bulk density (Mg m^{-3})	
	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18
Main plot Fertility level								
F_1- 100% RDF	7.40	7.45	0.269	0.271	0.36	0.364	1.379	1.369
F_2- 75% RDF	7.37	7.41	0.263	0.265	0.354	0.356	1.385	1.374
SEm±	0.06	0.05	0.003	0.002	0.004	0.003	0.016	0.012
CD 5%	NS	NS	NS	NS	NS	NS	NS	NS
Zinc level (kg Zn ha^{-1})								
Zn_0- 0	7.38	7.41	0.263	0.265	0.355	0.359	1.386	1.375
Zn_1- 5	7.39	7.43	0.267	0.268	0.358	0.36	1.383	1.374
Zn_2- 10	7.39	7.44	0.268	0.271	0.358	0.361	1.377	1.367
SEm±	0.08	0.07	0.003	0.003	0.005	0.003	0.02	0.015
CD 5%	NS	NS	NS	NS	NS	NS	NS	NS
Sub plot Cow urine (l ha^{-1})								
U_0- 0 (Control)	7.31	7.40	0.264	0.267	0.355	0.357	1.384	1.375
U_1-4000 each at Sowing and CRI	7.42	7.43	0.266	0.268	0.357	0.36	1.383	1.371
U_2-4000 each at Sowing, CRI and SE	7.43	7.45	0.268	0.269	0.359	0.363	1.379	1.37
SEm±	0.05	0.03	0.002	0.002	0.003	0.002	0.01	0.01
CD 5%	NS	NS	NS	NS	NS	NS	NS	NS

Table 5: Effect of varying levels of fertility, zinc and cow urine application on available N, P, K and Zn in soil after harvesting of wheat.

Treatments	Available N (kg ha^{-1})		Available P (kg ha^{-1})		Available K (kg ha^{-1})		Available Zn (mg kg^{-1})	
	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18
Main plot Fertility level								
F_1- 100% RDF	207.96	211.57	18.51	19.30	190.51	191.16	1.04	1.12
F_2- 75% RDF	200.86	204.71	17.99	18.89	187.24	187.88	1.03	1.11
SEm±	2.36	2.28	0.33	0.29	2.21	1.90	0.02	0.01
CD 5%	NS	NS	NS	NS	NS	NS	NS	NS
Zinc level (kg Zn ha^{-1})								
Zn_0- 0	199.10	203.25	17.86	18.65	187.61	188.22	0.98	1.08
Zn_1- 5	206.67	210.05	18.39	19.30	189.16	189.74	1.06	1.13
Zn_2- 10	207.46	211.12	18.50	19.34	189.85	190.60	1.07	1.13
SEm±	2.90	2.79	0.40	0.35	2.70	2.33	0.02	0.02
CD 5%	NS	NS	NS	NS	NS	NS	NS	NS
Sub plot Cow urine (l ha^{-1})								
U_0- 0 (Control)	200.61	204.32	17.85	18.69	187.82	188.84	1.02	1.11
U_1-4000 each at Sowing and CRI	205.07	208.85	18.39	19.27	189.04	189.54	1.04	1.12
U_2-4000 each at Sowing, CRI and SE	207.56	211.25	18.51	19.33	189.76	190.20	1.04	1.12
SEm±	2.36	2.29	0.29	0.25	1.47	1.10	0.01	0.01
CD 5%	NS	NS	NS	NS	NS	NS	NS	NS

Table 6: Effect of varying levels of fertility, zinc and cow urine application on economics of wheat.

Treatments	Cost of cultivation (` ha^{-1})		Gross return (` ha^{-1})		Net return (` ha^{-1})		B:C	
	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18
Main plot Fertility level								
F_1- 100% RDF	47760	47760	122342	124195	74582	76435	1.56	1.60
F_2- 75% RDF	45779	45779	111469	113170	65689	67391	1.44	1.48
SEm±	—	—	1199	978	1199	978	0.03	0.02
CD 5%	—	—	3777	3081	3777	3081	0.08	0.07
Zinc level (kg Zn ha^{-1})								
Zn_0- 0	45324	45324	110863	112711	65539	67387	1.45	1.49
Zn_1- 5	46770	46770	118708	120180	71938	73410	1.54	1.58
Zn_2- 10	48215	48215	121145	123156	72930	74941	1.51	1.56
SEm±	—	—	1468	1197	1468	1197	0.03	0.03
CD 5%	—	—	4625	3773	4625	3773	NS	NS
Sub plot Cow urine (l ha^{-1})								
U_0- 0 (Control)	42706	42706	109718	111822	67012	69116	1.57	1.62
U_1-4000 each at Sowing and CRI	47582	47582	119448	120988	71865	73406	1.51	1.54
U_2-4000 each at Sowing, CRI and SE	50020	50020	121550	123237	71530	73217	1.43	1.46
SEm±	—	—	1034	938	1034	938	0.02	0.02
CD 5%	—	—	3017	2737	3017	2737	0.07	0.06

Table 7: Residual effect of varying levels of fertility, zinc and cow urine application on green and dry fodder yield of fodder maize

Treatments	Yield			
	Green fodder yield (q ha^{-1})		Dry fodder yield (q ha^{-1})	
	2017	2018	2017	2018
Main plot Fertility level				
F_1- 100% RDF	427.78	443.59	74.80	77.65
F_2- 75% RDF	408.85	425.38	70.10	73.11
SEm±	4.44	3.93	0.90	0.86
CD 5%	13.98	12.40	2.82	2.71
Zinc level (kg Zn ha^{-1})				
Zn_0- 0	405.83	423.12	69.71	72.61
Zn_1- 5	422.22	438.39	73.33	76.22
Zn_2- 10	426.89	441.94	74.30	77.30
SEm±	5.43	4.82	1.10	1.05
CD 5%	17.12	15.18	3.46	3.32
Sub plot Cow urine (l ha^{-1})				
U_0- 0 (Control)	413.11	429.96	71.29	74.59
U_1-4000 each at Sowing and CRI	419.67	435.67	72.53	75.32
U_2-4000 each at Sowing, CRI and SE	422.17	437.83	73.52	76.22
SEm±	3.22	2.44	0.64	0.67
CD 5%	NS	NS	NS	NS

Table 8: Residual effect of varying levels of fertility, zinc and cow urine application on physico-chemical properties of soil after harvesting fodder maize

	Soil pH		Soil EC (dS m^{-1})		Soil organic carbon (%)		Soil bulk density (Mg m^{-3})	
	2017	2018	2017	2018	2017	2018	2017	2018
Main plot Fertility level								
F_1- 100% RDF	7.37	7.39	0.257	0.261	0.358	0.360	1.383	1.376
F_2- 75% RDF	7.35	7.37	0.254	0.256	0.354	0.356	1.389	1.383
SEm±	0.07	0.07	0.003	0.003	0.003	0.003	0.015	0.014
CD 5%	NS	NS	NS	NS	NS	NS	NS	NS
Zinc level (kg ha^{-1} Zn)								
Zn_0- 0	7.29	7.31	0.250	0.254	0.355	0.357	1.396	1.384
Zn_1- 5	7.38	7.39	0.257	0.260	0.357	0.358	1.384	1.381
Zn_2- 10	7.42	7.44	0.259	0.261	0.357	0.359	1.379	1.373
SEm±	0.09	0.08	0.003	0.003	0.004	0.004	0.018	0.017
CD 5%	NS	NS	NS	NS	NS	NS	NS	NS
Sub plot Cow urine (l ha^{-1})								
U_0- 0 (Control)	7.30	7.34	0.252	0.256	0.352	0.354	1.394	1.388
U_1-4000 each at Sowing and CRI	7.35	7.40	0.257	0.260	0.358	0.360	1.384	1.377
U_2-4000 each at Sowing, CRI and SE	7.44	7.40	0.257	0.260	0.359	0.361	1.381	1.374
SEm±	0.05	0.04	0.003	0.002	0.003	0.002	0.014	0.014
CD 5%	NS	NS	NS	NS	NS	NS	NS	NS

Table 9: Residual effect of varying levels of fertility, zinc and cow urine application on available N, P, K and Zn in soil after harvesting of fodder maize

Treatments	Available N (kg ha^{-1})		Available P (kg ha^{-1})		Available K (kg ha^{-1})		Available Zn (mg kg^{-1})	
	2017	2018	2017	2018	2017	2018	2017	2018
Main plot Fertility level								
F_1- 100% RDF	196.26	198.71	17.76	18.55	188.09	189.07	0.98	1.08
F_2- 75% RDF	194.59	195.45	17.11	17.86	186.01	187.27	0.97	1.06
SEm±	3.10	2.55	0.23	0.22	3.29	2.11	0.01	0.01
CD 5%	NS	NS	NS	NS	NS	NS	NS	NS
Zinc level (kg Zn ha^{-1})								
Zn_0- 0	194.78	196.32	17.31	17.97	186.11	187.15	0.95	1.06
Zn_1- 5	195.41	197.10	17.48	18.07	187.42	188.20	0.99	1.07
Zn_2- 10	196.09	197.82	17.52	18.58	187.64	189.16	0.99	1.10
SEm±	3.80	3.13	0.28	0.27	4.03	2.58	0.02	0.01
CD 5%	NS	NS	NS	NS	NS	NS	NS	NS
Sub plot Cow urine (l ha^{-1})								
U_0- 0 (Control)	194.70	195.98	17.22	17.94	186.42	187.71	0.96	1.07
U_1-4000 each at Sowing and CRI	195.45	196.92	17.38	18.26	187.09	188.22	0.98	1.08
U_2-4000 each at Sowing, CRI and SE	196.13	198.33	17.71	18.42	187.64	188.58	0.99	1.08
SEm±	2.32	1.82	0.15	0.18	2.90	1.80	0.01	0.01
CD 5%	NS	NS	NS	NS	NS	NS	NS	NS

Table 10: Residual effect of varying levels of fertility, zinc and cow urine application on economics of succeeding fodder maize

Treatments	Cost of cultivation (` ha^{-1})		Gross return (` ha^{-1})		Net return (` ha^{-1})		B: C	
	2017	2018	2017	2018	2017	2018	2017	2018
Main plot Fertility level								
F_1- 100% RDF	21885	21885	55611	57667	33726	35782	1.54	1.64
F_2- 75% RDF	21885	21885	53151	55299	31266	33414	1.43	1.53
SEm±	-	-	577	511	577	511	0.026	0.023
CD 5%	-	-	1818	1611	1818	1611	0.083	0.074
Zinc level (kg Zn ha^{-1})								
Zn_0- 0	21885	21885	52758	55006	30873	33121	1.41	1.51
Zn_1- 5	21885	21885	54889	56991	33004	35106	1.51	1.60
Zn_2- 10	21885	21885	55496	57453	33611	35568	1.54	1.63
SEm±	-	-	706	626	706.43	626	0.032	0.029
CD 5%	-	-	2226	1974	2226	1974	0.102	0.090
Sub plot Cow urine (l ha^{-1})								
U_0- 0 (Control)	21885	21885	53704	55894	31819	34009	1.45	1.55
U_1-4000 each at Sowing and CRI	21885	21885	54557	56637	32672	34752	1.49	1.59
U_2-4000 each at Sowing, CRI and SE	21885	21885	54882	56918	32997	35033	1.51	1.60
SEm±	-	-	419	317	419	317	0.019	0.014
CD 5%	-	-	NS	NS	NS	NS	NS	NS

4. Conclusion

On the basis of two years field experiment it is concluded that application of 100% RDF (150-60-60 kg ha^{-1} N P K) and 5 kg Zn ha^{-1} and cow urine at 12000 l ha^{-1} equally distributed at sowing, CRI and spike emergence stages may be followed for higher yield and better quality of wheat however in terms of economics 100% RDF and 10 kg Zn ha^{-1} and cow urine at 8000 l ha^{-1} equally distributed at sowing, CRI and spike emergence stages may be followed in irrigated condition of Varanasi. Soil parameters (pH, EC, organic carbon and bulk density and nutrient status *viz.* available N, P, K and Zn in soil) after wheat and succeeding fodder maize were not significantly affected due to various fertility, zinc and cow urine levels during both the years of study.

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