Original Research Article

Evaluating optimum cow urine application rate at varying fertility and zinc levels on wheat (*Triticum aestivum* L.) productivity under dairy based farming system in Varanasi tract

Abstract

The field experiment was carried out in two consecutive 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.) under irrigated condition of Varanasi. Results showed that application of the fertilizer at 100% RDF (F_1) recorded significantly higher growth parameters *viz*. plant height, number of tiller m^{-1} row length; yield attributes *viz*. number of effective tiller m^{-2}, spike length, grains spike^{-1} and test weight as well as grain and straw yield than 75% RDF (F_2) during both the years. Among the zinc levels, zinc applied at 10 kg ha^{-1} though remained comparable to 5 kg Zn ha^{-1}, recorded significantly higher values of these parameters over control. Cow urine @ 12000 l ha^{-1} applied equally at sowing, CRI and spike emergence stages (U_2) gave higher values of plant height, number of tiller m^{-1} row length, spike length and number of grain spike^{-1} which being at par with U_1 (4000 l ha^{-1} cow urine each at sowing and CRI), both recorded significantly higher values than control. However, with respect to effective tillers m^{-2}, grain and straw yield, significant increase was noticed with each increment of cow urine, recording maximum at 12000 l ha^{-1} during both the years.

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

1. Introduction

Wheat (*Triticum aestivum* L) is the major staple food crop of the world, occupying maximum area (220.06 m ha) and stands second in production (763.2 m t) after maize and third in the productivity (3.49 m t ha^{-1}) after maize and rice (USDA, 2019). It is an essential component of food in more than 40 countries, contributes 35 per cent to the world's food basket and meets 19 per cent of calories and 20 per cent of protein requirements of the world population (DFI committee estimates, 2018) besides being a major source of dietary fibre, carbohydrates, mineral and vitamins in human nutrition since decades. India is the second largest wheat producing country (98.51 m t) after china, contributes 15.36% to the world wheat production. However, with respect to area, it ranks first (30.79 m ha), followed by Russia and China (USDA, 2019). In India, wheat is the second major staple cereal crop after rice and gives a significant contribution to food and nutrition security as well as agricultural development. However, the productivity of wheat is low (3216 kg ha^{-1}) compared to the world average (3490 kg ha^{-1}). India needs to produce wheat about 115 m t by 2030 and 140 m t by

2050 to feed the growing population; this is equivalent to 46% higher production than the present production level (Vision 2050, 2015). Declining soil fertility as well as inadequate, unbalanced and inefficient use of fertilizers is the major constraints which lead to low wheat productivity (Yadav *et al*., 2000; Dwivedi *et al*., 2001). Though, the application of synthetic fertilizers with intensive agronomic practices had greatly enhanced the wheat productivity (Khan *et al*., 2009) during the last 50 years but the extensive and irrational fertilizer use has resulted in negative impact on soil health (Hammad *et al*., 2010). Beside this, under increasing world energy crisis, the cost of chemical fertilizers is increasing but it has been established that the renewable sources of plant nutrients *viz*. organic sources integrated with chemical fertilizers increases productivity as well as maintain soil health (Pullicinoa *et al*., 2009). Cow urine has been used for various purposes *viz*. medicinal and agricultural from *vedic* period due to its special characteristics and lower cost. Amongst various organic sources, cow urine besides nitrogen, also has good amount of phosphate, potassium, sulphur, sodium, manganese, iron, silicon, chlorine, carbolic acid, salt, enzymes and hormones (Saunders, 1982. The amount of total nitrogen in cow urine ranges from 6.8-21.1 g N litre^{-1} in which urea contribute 69%, hippuric acid 5.8%, allantoin 7.3%, creatine 2.5%, creatinine 3.7%, uric acid 1.3%, xanthin plus hypoxanthin 0.5%, ammonia 2.8% and free amino acid nitrogen 1.3% (Bristow *et al*., 1992). Primary plant nutrients play an important role in wheat production. Nitrogen is vital component of the cell and growth components such as chlorophyll, many protein molecules, enzyme particles, DNA structural molecules *viz*. nucleotides, alkaloids and many other substances, contribute significantly in plant growth, development and reproduction. Phosphorus is the key element which plays the important role in basic photosynthesis reactions, energy transfer, transformation of sugar, metabolic processes and starch and nutrient movement in plants. Likewise, potassium is the component of many enzymes, performs major role in carbohydrates synthesis, disease resistance as well as tolerance to adverse environmental conditions in plants through osmotic regulation of the cell. At present, zinc deficiency in Indian soils has been recognised as the widespread micronutrient deficiency and it comes next to N and P. So, nearly 50% soils in north India are low in Zn and likely to respond to its application (Sharma *et al*., 2016). Zinc is required in completing basic plant life functions *viz*. chlorophyll synthesis, nitrogen uptake and metabolism, protein quality and photosynthesis etc. (Potarzycki *et al*., 2009). It is the component of many enzymes *viz*. carbonic anhydrase as well as proteins. Hence, the current investigation was carried out to evaluate the performance of cow urine as a potential organic fertilizer source in wheat production along with fertility and zinc levels.

2. Materials and Methods

The field study was conducted at the Agricultural Research Farm, Banaras Hindu University, Varanasi (U.P.) in two successive years of 2016-17 and 2017-18. The soil of the experimental site was sandy clay loam in texture with slightly alkaline soil pH (7.35), 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 experiment was laid out in split plot design with three replications. The main plot treatment comprised of combinations of two fertility levels (100% RDF and 75% RDF) and three zinc levels (0, 5 and 10 kg Zn ha^{-1}) and in sub plots, three cow urine levels (U_2 - 12000 l ha^{-1} equally applied 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}) were taken. In control plot, water was applied @ 4000 l ha^{-1} at all the stages (Sowing, CRI and SE). Similarly in U_1, water @ 4000 l ha^{-1} was applied at spike emergence. Under 100% RDF, 150 kg N, 60 kg P_2O_5 and 60 kg K_2O was applied. The nutrient application was done as per treatment through Urea, DAP, MOP and $ZnSO_4.H_2O$. Half of the recommended dose of nitrogen and full doses of P, K and Zn were applied as basal and rest half dose of nitrogen was top dressed through Urea in two equal splits at CRI and spike emergence stages. The pure cow urine was collected from cattle shed of IFS model of the Institute of Agricultural Sciences, BHU, Varanasi and stored in plastic cans. The application of the cow urine was done 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 as per treatment. Wheat variety "HD 2967" 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 as per requirement of the crop and the need based plant protection measures were adopted. Similarly, all other recommended package of practices was followed. The observations on growth parameters *viz*. plant height and number of tiller m^{-1} row length at 40, 70, 100 DAS and at harvest and maturity characters *viz*. number of effective tiller m^{-2}, spike length, grains $spike^{-1}$, test weight as well as grain and straw yield were recorded during both the years. The data were analyzed by the standard procedure for analysis of variance as described by Gomez and Gomez, 1984.

Comment [HC1]: How the application of cow urine with watering cane
Is possible If trail is conducted in 1 hac ?

3. Results and Discussion

3.1 Effect of varying level of fertility, zinc and cow urine on growth parameters

3.1.1 Plant height

Plant height of wheat was distinctly affected under different fertility levels. Application of 100% RDF significantly enhanced the plant height at all the growth stages than 75% RDF during both the years (Table 1). Plant height progressively increased upto 100 DAS and thereafter it practically seized. This might be ascribed to senescence towards maturity and switch over of the plants from vegetative to reproductive stage thus food material which was being utilized for growth till now was transferred to fruit formation. The balanced and adequate supply of macronutrient *viz*.

NPK might have helped in plant growth by rapid cell division and cell elongation in plant meristemic regions and more protein synthesis which are consequently developed into protoplast and thereby protein is set free for development of cell wall materials which is presented morphologically in terms of increased plant height. These findings are in accordance with the results of Rahman *et al*., 2016 and Samimi and Thomas 2016.

Comment [HC2]: Add some recent references

Application of 10 kg Zn ha^{-1} recorded maximum plant height and being at par with 5 kg Zn ha^{-1} both produced taller plants over control. However, at 40 DAS, plant height with application of 5 kg Zn ha^{-1} remained comparable with control. The increased plant growth with increasing zinc levels might be due to its vital role in enzymatic systems such as carbonic anhydrase which plays an important role in CO_2 transportation in photosynthesis (Srivastava and Gupta, 1996) and nitrogen metabolism and zinc induced growth regulators such as gibberellins, kinetin and indole-3-acetic acid. These findings are in close conformity to those of Jan *et al*., 2013 and Sharma *et al*., 2016.

Cow urine application distinctly affected the plant height of wheat at all the growth stages. Application of the cow urine @ 12000 l ha^{-1} equally applied at sowing, CRI and SE recorded highest plant height but being comparable with 8000 l ha^{-1} equally applied at sowing and CRI, both produced significantly taller plants over control during both the years of study. The beneficial effect of cow urine application on plant could be attributed to the various minerals, enzymes and hormones contained in cow urine which might involved in regulations of physiological processes inside plant and enhanced microbial activity in rhizosphere leading to better absorption of nutrients which ultimately increased plant growth (Vahanka *et al*., 2010). The results of the current study are in agreement with the findings of Sadhukhan *et al*., 2018, Devakumar *et al*., 2014 in maize and Gopakkali and Channanaik, 2010 in rice.

3.1.2 Number of tillers m^{-1} row length

Data presented in Table 2 revealed that, application of 100 % RDF gave significantly higher tillers m^{-1} row length at all the growth stages than 75% RDF during both the experimental years. The number of tiller in wheat was increased upto 100 DAS, thereafter, it reduced slightly which might be due to mortality of late produced tillers resulting from intraspecies competition for higher space and nutrients. Balanced and adequate fertilization in wheat increased number of tiller as nitrogen applied with phosphorus and potassium might have increased protoplasmic content and metabolic processes of the plant and nutritional conditions of the mother culm which in turn helped in expansion of auxillary buds. Besides this, according to Ali *et al*., 2003, increasing nutrient levels reduced degeneration of tillers which favour to maintain more number of the effective tillers. Alike results were also reported by Samimi and Thomas, 2016 and Jat *et al*., 2013.

Similarly, the various levels of zinc exerted significant impact on number of tiller m^{-1} row length (Table 2). Application of 10 kg Zn ha^{-1} produced highest number of tiller m^{-1} row length at all the growth stages. Though, it remained comparable to 5 kg Zn ha^{-1}, both proved statistically superior over control during both the years of assessment. The higher number of tiller with increasing zinc application can be attributed to the fact that zinc induces chlorophyll content (Table 3) which accelerates rate of photosynthesis and increased production of assimilates needed for tiller production (Barak and Helmke, 1993). These findings are in accordance with the observations of Jan *et al*., 2013.

Marked effect of cow urine application was observed on number of tiller m^{-1} row length during both the years of investigation. Increasing levels of cow urine application from 0 to 12000 l ha^{-1} increased number of tiller m^{-1} row length at all the growth stages. Highest and medium levels of cow urine application being comparable, both were significantly superior to control. The increased number of tiller with application of higher rate of cow urine might be viewed as cow urine is a source of primary, secondary and micro nutrients as well as various types of hormones and enzymes which are quickly absorbed by plant might have favoured physiological reaction in plant system towards higher growth and development, ultimately leading to more number of tiller. The similar views on number of tiller have been expressed by Sadhukhan and Bohra, 2017, Singh *et al*., 2014 and Gopakkali and Channanaik, 2010 in rice.

3.2 Effect of varying level of fertility, zinc and cow urine on yield attributes

Increasing levels of fertilizer application from 75% RDF to 100% RDF (F_1) significantly enhanced the yield attributes *viz*. number of effective tiller m^{-2}, spike length, grains $spike^{-1}$ and test weight during both the years of study (Table 3). This could be ascribed to increased sink capacity which was possibly due to better uptake of major nutrients that enhanced dry matter production or source capacity of the plant like leaf area index, net assimilation rate and photosynthetic efficiency leading to the production of favourable growth components which resulted into improved yield attributes. These findings are in conformity with the findings of Srivastava and Singh, 2014 and Mishra *et al*., 2017.

Application of zinc to wheat markedly influenced the yield attributes *viz*. number effective tiller m^{-2}, length of spike, number of grain $spike^{-1}$ and test weight during both the years of experimentation. Application of 10 kg Zn ha^{-1} recorded maximum values of yield attributes and being at par with 5 kg Zn ha^{-1}, both proved significantly superior over control. This can be attributed to the favourable effect of zinc application on growth components (Table 1&2) which perhaps due to the fact that Zn plays an important role in basic photosynthesis reactions, chlorophyll synthesis, growth hormones formation, auxin and nitrogen metabolism etc. which persuade the plant to enhance the photosynthetic activity resulting into increased sink capacity, ultimately enhanced yield component and yield. Similar results were also reported by Zeidan *et al*., 2010 and Jan *et al*., 2013.

Increasing levels of cow urine application from 0 to 12000 l ha^{-1} markedly increased yield attributes of wheat *viz*. number of effective tiller m^{-2}, spike length and grains $spike^{-1}$. However, for spike length and grains $spike^{-1}$, the differences between 8000 and 12000 l ha^{-1} cow urine levels did not touch the level of significance. The test weight was slightly increased with increasing levels of cow urine application but the differences were not varied statistically. The increased yield attributes with increasing cow urine application might be due to increased availability of major as well as secondary and micro nutrient elements, hormones and enzymes helpful in plant growth and development leading to higher dry matter production and increased supply of photosynthates for formation of yield components of wheat. Similar observations were also reported by Sadhukhan *et al*., 2018 in wheat.

3.3 Effect of varying level of fertility, zinc and cow urine on yield

Grain and straw yield of the wheat showed marked variation under two fertility levels (Table 4). The fertilizer application at 100% RDF produced significantly higher grain and straw yield of wheat during both the years over 75% RDF. This could be attributed to adequate and balanced fertilization at 100% RDF which increased availability and assimilation of fertilizer elements that promoted higher growth parameters *viz*. plant height, number of tiller as well as leaf chlorophyll content (Table 1, 2 and 3) leading to more dry matter production (Data not reported) which resulted into better source and sink relationship and thereby yield. The findings of the present investigation are agreed with those of Samimi and Thomas, 2016 and Rahman *et al*., 2016.

As regards the zinc application, increasing zinc levels favourably enhanced the grain and straw yield of wheat. The highest grain and straw yield were recorded with the supplementation of 10 kg Zn ha^{-1} followed by 5 kg Zn ha^{-1} and both being at par recorded significantly higher grain and straw yield of wheat over control. The enhancement in yield may be assigned to favourable impact of zinc on the vegetative growth which positively impacted the reproductive growth of the plant and finally improved yield. These findings are in close conformity with those of Singh *et al*., 2004a; Singh *et al*., 2004a and Ahmadi *et al*., 2016.

Increasing levels of cow urine from 0 to 12000 l ha^{-1} correspondingly enhanced the grain and straw yield and the differences were significant between any two levels. As compared to control, application of 12000 and 8000 l ha^{-1} cow urine caused 13.05 and 8.25% increase in grain yield during first year and 11.45 and 8.07% increment during second year, respectively. This could be due to the increased values of growth parameters which resulted into higher yield attributes (Table 3), ultimately leading to increased yield. The reportings of the current study are in close proximity with those of Devakumar *et al*., 2014 in maize and Sadhukhan *et al*., 2018 in wheat.

3.4 Harvest Index

The increasing levels of fertility, zinc and cow urine application from lowest to highest levels though showed increasing trend of harvest index but the differences failed to touch the level of significance (Table 3). This shows that fertilizer, zinc and cow urine application contributed almost equally to both the grain as well as straw production.

Recommendation

On the basis of two years study it is recommended that application of 100% RDF (150-60-60 kg ha^{-1} N P K) and 5 kg Zn ha^{-1} and cow urine @ 12000 l ha^{-1} equally applied at sowing, CRI and spike emergence stages may be followed for higher yield of wheat under irrigated condition of Varanasi.

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Table 1: Effect of varying levels of fertility, zinc and cow urine application on plant height at different stages.

Treatments	Plant height (cm)							
	40 DAS		70 DAS		100 DAS		At harvest	
	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18
Main plot **Fertility level**								
F_1- 100% RDF	**41.02**	**42.56**	**71.55**	**73.57**	**103.57**	**105.71**	**103.62**	**104.61**
F_2- 75% RDF	**38.48**	**40.33**	**68.81**	**70.16**	**98.71**	**100.22**	**98.44**	**99.26**
SEm±	**0.41**	**0.39**	**0.79**	**0.64**	**1.27**	**1.04**	**1.11**	**1.01**
CD 5%	**1.29**	**1.24**	**2.49**	**2.02**	**4.02**	**3.29**	**3.48**	**3.18**
Zinc level (kg Zn ha^{-1})								
Zn_0- 0	**38.76**	**40.29**	**67.47**	**69.90**	**97.44**	**99.83**	**97.30**	**98.77**
Zn_1- 5	**39.68**	**41.54**	**70.67**	**72.63**	**102.38**	**103.98**	**101.82**	**103.03**
Zn_2- 10	**40.81**	**42.51**	**72.39**	**73.07**	**103.60**	**105.07**	**103.97**	**104.01**
SEm±	**0.50**	**0.48**	**0.97**	**0.79**	**1.56**	**1.28**	**1.35**	**1.24**
CD 5%	**1.59**	**1.52**	**3.05**	**2.48**	**4.92**	**4.03**	**4.27**	**3.90**
Sub plot **Cow urine (l ha^{-1})**								
U_0- 0 (Control)	**38.60**	**40.16**	**68.17**	**69.94**	**98.33**	**100.33**	**98.75**	**99.16**
U_1-4000 each at Sowing and CRI	**39.96**	**41.71**	**70.65**	**72.32**	**101.53**	**103.33**	**101.52**	**102.41**
U_2-4000 each at Sowing, CRI and SE*	**40.70**	**42.46**	**71.72**	**73.34**	**103.56**	**105.23**	**102.82**	**104.24**
SEm±	**0.27**	**0.27**	**0.78**	**0.54**	**0.95**	**0.98**	**0.68**	**0.92**
CD 5%	**0.80**	**0.78**	**2.29**	**1.58**	**2.78**	**2.85**	**2.00**	**2.68**

* Spike Emergence

Table 2: Effect of varying levels of fertility, zinc and cow urine application on tiller production at different stages.

Treatments	Number of tiller^{-1} m row length							
	40 DAS		70 DAS		100 DAS		At harvest	
	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18
Main plot **Fertility level**								
F_1- 100% RDF	**96.56**	**99.37**	**127.74**	**131.89**	**125.81**	**129.33**	**122.78**	**124.30**
F_2- 75% RDF	**87.15**	**90.70**	**121.89**	**124.33**	**114.89**	**118.56**	**111.22**	**114.52**
SEm±	**1.87**	**1.48**	**1.75**	**1.45**	**1.77**	**1.73**	**2.17**	**2.11**
CD 5%	**5.89**	**4.67**	**5.51**	**4.57**	**5.59**	**5.46**	**6.83**	**6.66**
Zinc level (kg Zn ha^{-1})								
Zn_0- 0	**86.39**	**89.72**	**119.22**	**123.33**	**112.28**	**116.17**	**110.39**	**112.83**
Zn_1- 5	**93.67**	**96.22**	**126.50**	**129.61**	**123.67**	**126.94**	**119.39**	**121.11**
Zn_2- 10	**95.50**	**99.17**	**128.72**	**131.39**	**125.11**	**128.72**	**121.22**	**124.28**
SEm±	**2.29**	**1.82**	**2.14**	**1.78**	**2.17**	**2.12**	**2.66**	**2.59**
CD 5%	**7.21**	**5.72**	**6.75**	**5.60**	**6.85**	**6.69**	**8.37**	**8.15**
Sub plot **Cow urine (l ha^{-1})**								
U_0- 0 (Control)	**87.06**	**89.61**	**119.89**	**123.50**	**115.78**	**119.50**	**111.44**	**114.33**
U_1-4000 each at Sowing and CRI	**92.28**	**96.00**	**125.61**	**129.11**	**120.56**	**124.50**	**118.00**	**120.61**
U_2-4000 each at Sowing, CRI and SE*	**96.22**	**99.50**	**128.94**	**131.72**	**124.72**	**127.83**	**121.56**	**123.28**
SEm±	**1.71**	**1.24**	**1.62**	**1.40**	**1.57**	**1.49**	**2.24**	**2.16**
CD 5%	**5.00**	**3.61**	**4.73**	**4.09**	**4.59**	**4.36**	**6.55**	**6.31**

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

Treatments	**Number of effective tiller m^{-2}**		**Spike length (cm)**		**Number of grain $spike^{-1}$**		**Test weight (g)**	
	2016-17	**2017-18**	**2016-17**	**2017-18**	**2016-17**	**2017-18**	**2016-17**	**2017-18**
Main plot **Fertility level**								
F_1- 100% RDF	**398.96**	**403.11**	**13.37**	**13.48**	**51.48**	**52.06**	**41.97**	**42.13**
F_2- 75% RDF	**360.41**	**364.63**	**12.42**	**12.57**	**49.22**	**49.85**	**41.08**	**41.40**
SEm±	**5.99**	**5.49**	**0.13**	**0.14**	**0.55**	**0.54**	**0.25**	**0.23**
CD 5%	**18.88**	**17.29**	**0.40**	**0.44**	**1.74**	**1.70**	**0.79**	**0.72**
Zinc level (kg Zn ha^{-1})								
Zn_0- 0	**358.11**	**362.83**	**12.19**	**12.35**	**47.31**	**47.78**	**39.73**	**40.06**
Zn_1- 5	**383.72**	**386.67**	**13.01**	**13.14**	**51.09**	**51.79**	**42.22**	**42.40**
Zn_2- 10	**397.22**	**402.11**	**13.49**	**13.57**	**52.65**	**53.30**	**42.64**	**42.84**
SEm±	**7.34**	**6.72**	**0.16**	**0.17**	**0.68**	**0.66**	**0.31**	**0.28**
CD 5%	**23.12**	**21.17**	**0.49**	**0.54**	**2.13**	**2.08**	**0.96**	**0.89**
Sub plot **Cow urine (l ha^{-1})**								
U_0- 0 (Control)	**364.11**	**370.00**	**12.39**	**12.21**	**48.25**	**48.71**	**41.07**	**41.28**
U_1-4000 each at Sowing and CRI	**380.28**	**385.67**	**12.98**	**13.38**	**50.68**	**51.23**	**41.54**	**41.83**
U_2-4000 each at Sowing, CRI and SE*	**394.67**	**395.94**	**13.32**	**13.58**	**52.12**	**52.92**	**41.98**	**42.19**
SEm±	**4.54**	**3.25**	**0.13**	**0.12**	**0.58**	**0.49**	**0.28**	**0.26**
CD 5%	**13.26**	**9.49**	**0.39**	**0.34**	**1.68**	**1.42**	**NS**	**NS**

Table 4: Effect of varying levels of fertility, zinc and cow urine application on yield.

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**	**40.09**	**40.22**
SEm±	**62**	**49**	**113**	**112**	**0.57**	**0.50**
CD 5%	**194**	**154**	**355**	**354**	**NS**	**NS**
Zinc level (kg Zn ha^{-1})						
Zn_0- 0	**4353**	**4456**	**6501**	**6607**	**40.02**	**40.23**
Zn_1- 5	**4662**	**4744**	**6958**	**7041**	**40.17**	**40.29**
Zn_2- 10	**4777**	**4888**	**7033**	**7185**	**40.40**	**40.51**
SEm±	**75**	**60**	**138**	**138**	**0.70**	**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**	**39.94**	**40.06**
U_1-4000 each at Sowing and CRI	**4646**	**4765**	**6862**	**7017**	**40.09**	**40.44**
U_2-4000 each at Sowing, CRI and SE*	**4854**	**4914**	**7136**	**7215**	**40.57**	**40.54**
SEm±	**56**	**48**	**66**	**65**	**0.44**	**0.33**
CD 5%	**162**	**141**	**192**	**189**	**NS**	**NS**