International Journal of Forestry and Crop Improvement
Volume 6 | Issue 1 | June, 2015 | 64-70 | Visit us : www.researchjournal.co.in
e ISSN-2230-9411

RESEARCH ARTICLE

DOI: 10.15740/HAS/IJFCI/6.1/64-70

Growth, yield and nutrient contents and uptake by wheat as influnced by different residue management practices and nitrogen levels

K.A. SHAH, B.M. TANDEL AND G.J. BHIMANI

ABSTRACT : An experiment was conducted for two consecutive years on same site at AAU, Anand, during the year 2004-05 and 2005-06, to evaluate the effect of crop residue management practices and nitrogen levels on yield and nutrient content and uptake by wheat. Eighteen treatment combination involving six residue management practices and three levels of nitrogen were tested in Factorial Randomized Block Design replicated thrice. Growth and yield attributes of wheat crop were increased due to different residue management treatments and FYM than that of control. Addition of wheat straw with N or P_2O_5 or both proved better than its application alone. However, addition of wheat straw @ 5 t/ ha along with 20 kg N and 20 kg P_2O_5 / ha at 30 days before sowing was produced significantly the highest plant height at harvest, number of effective ear heads, length of era heads, test weight, grain and straw yields of wheat. Nitrogen, phosphorus and potash content and uptake by grain and straw of wheat were also found higher in same treatment. The application of 120 kg N/ha was register significantly the highest all the growth and yield contributing character, including the grain and straw yields as well as net return of wheat. Similarly, nitrogen, phosphorus and potash content and uptake by grain and straw of wheat were recorded highest under the same treatment.

KEY WORDS : Wheat straw incorporation, Nitrogen, Nutrients content, Grain yield

HOW TO CITE THIS ARTICLE : Shah, K.A., Tandel, B.M. and Bhimani, G.J. (2015). Growth, yield and nutrient contents and uptake by wheat as influnced by different residue management practices and nitrogen levels. *Internat. J. Forestry & Crop Improv.,* **6** (1) : 64-70.

ARTICLE CHRONICAL : Received : *21.03.2015;* Revised : *27.04.2015;* Accepted : *29.05.2015*

INTRODUCTION

Increasing demand of food to feed the ever growing population along with rising cost of chemical fertilizers and depleting soil fertility owing to intensive cropping system necessitates judicious use of renewable (organic) and non-renewable (inorganic) sources of input energy production which minimize the dependence of crop production on commercial source of energy. Under this junction of national energy crisis, the urgent need is to test easily available alternative sources of energy as farm yard manure, green manuring, rice straw, wheat straw, etc for sustainable crop production and soil health as well to sustain the soil fertility. The complementary effect of organic and inorganic sources may be pronounced in cropping system rather than a single crop.

Crop residues are important renewable organic sources of nutrients. Large quantities of crop residues

MEMBERS OF RESEARCH FORUM

Address of the Correspondence : **K.A. SHAH,** Krishi Vigyan Kendra (NAU), NAVSARI (GUJARAT) INDIA Email: ramnigade@gmail.com

Address of the Coopted Authors : B.M. TANDEL AND G.J. BHIMANI, Krishi Vigyan Kendra (NAU), NAVSARI (GUJARAT) INDIA

are available with the farmers which can be utilized as complementary sources to chemical fertilizer. Besides supplementing the fertilizers for major nutrients, crop residues are also important in improving the soil quality. The incorporation of such a large quantities of crop residues, resulted in temporary immobilization of plant nutrients, due to their wider C:N ratio. There by, leading to nitrogen deficiency at early stage of crop growth even after application of recommendation doses of nitrogen. Therefore, application of urea at the time of field preparation may accelerate the rate of decomposition of crop residues, resulting in to grater availability of nitrate N at early stage of crop growth.

Keeping all this in a view, the present experiment was planned to investigate the growth, yield and nutrients content and uptake by grain and straw of wheat as affected by different residue management practices and nitrogen levels.

EXPERIMENTAL METHODS

A field experiment was conducted at College Agronomy Farm, Anand Agricultural University, Anand, (22°-35' N and 72°-55' E) with an altitude of 45.1 m above mean sea level during the *Rabi* season of the years 2004-05 and 2005-06. The soil of the experimental field was loamy sand in texture (locally known as *Goradu* soil) having pH ranging from 7.8 to 8.0. The experimental soil was low in organic carbon and total nitrogen, medium in available phosphorus and high in available potassium. Eighteen treatments comprised of all possible combinations of six levels of residue management practices (R_0: control, R_1: wheat straw incorporation (WSI) @ 5 t ha^{-1} at 30 days before sowing (DBS), R_2: WSI @ 5 t/ ha + 20 kg N/ ha at 30 DBS, R_3: WSI @ 5 t/ ha + 20 kg P_2O_5 /ha at 30 DBS, R_4: WSI @ 5 t/ ha + 20 kg N plus 20 kg P_2O_5 /ha at 30 DBS and R_5: FYM @ 10 t / ha two DBS) and three levels of nitrogen application (N_1: 60 kg N ha^{-1}, N_2: 90 kg N/ ha and N_3: 120 kg N/ ha) were tested in Factorial Randomized Block Design with three replications. Entire quantity of wheat straw as per treatments was applied uniformly in experimental plots 30 days before sowing of wheat with irrigation. Then after, either nitrogen or phosphorus or both @ 20 kg/ ha as per treatments through urea for nitrogen and single super phosphate for P_2O_5 were applied uniformly in plots to decompose the wheat straw. The cellulolytic bacterial and fungus culture was also spraied on wheat straw applied plots for faster decomposition of wheat straw. Then, wheat straw was thoroughly mixed with the soil. FYM was applied as per treatment in the experimental plots just two days before sowing of wheat. Half treatmental N through urea was applied at the time of wheat sowing. Remaining half does of N was top dress after one month of sowing. Wheat variety GW-496 was selected and the crop raised as per recommended package of practices.

EXPERIMENTAL RESULTS AND ANALYSIS

The findings of the present study as well as relevant discussion have been presented under following heads :

Effect of residue managements practices :

The addition of wheat straw with or without inorganic fertilizer or application of FYM @ 10 t/ ha alone remarkably influenced the all the growth an yield attributing characters. Significantly the highest plant height at harest, total chlorophyll content at 30 DAS, number of effective ear heads m^{-2}, ear head length and test weight were found in the treatment R_4 as compared to control (R_0). The pant height at harvest, number of effective ear heads m^{-2}, length of ear head and test weight were increased up to the tune of 11.5, 9.1, 9.7 and 15.3 per cent over control, respectively. The increase in plant height might be due to incorporation of wheat straw along with inorganic N and P_2O_5 fertilizers at 30 DBS helps in easy decomposition and slowly releasing of nutrients in root zone area during the entire crop growth period, which resulted in better plant growth. The present findings are in close agreement with those reported by Subbaiah and Mittra (1997); Das *et al*. (2001) and Shivakumar and Mishra (2001). Number of effective ear heads m^{-2} were found maximum might be due to rapid mineralization of wheat straw increased in availability and uptake of nutrient during the critical physiological growth stages resulting in higher tiller production. Similar finding were also reported by Sharma and Bali (1998) and Brar *et al.* (2000). The ear head length increased might be due to increase in photosynthetic efficiency and adequate availability of nutrients. Wheat straw incorporation favorably increased grain weight with the enhancement in the uptake of nutrients at flowering and improvement in the size of the sink (productive tillers and ear head

length) to receive the source. These results closely resembled with those of Subbaiah and Mittra (1997) and Hemalatha *et al*. (2000). All the growth and yield attributing characters were observed significantly the lowest in control. Similar types of results were reported by Brar *et al*. (2000).

Application of wheat straw @ 5 t ha^{-1} at 30 DBS alone or with fertilizer nutrients significantly increased the grain and straw yields of wheat as compared to control as well as application of 10 t/ ha FYM alone. Incorporation of wheat straw @ 5 t/ ha at 30 DBS alone and wheat straw @ 5 t ha^{-1} along with 20 P_2O_5 /ha at 30 DBS remained at par in respect of grain and straw yields of wheat. Similarly, addition of wheat straw @ 5 t/ ha plus 20 kg N/ ha at 30 DBS and wheat straw with 20 kg P_2O_5 at 30 DBS also found at par in terms of yields of wheat. Significantly the highest grain yield (5472 kg ha^{-1}) and straw yield (8164 kg/ ha) of wheat were obtained under the incorporation of wheat straw @ 5 t/ ha plus 20 kg N and 20 kg P_2O_5 /ha at 30 DBS as compared to rest of treatments. The increase in grain and straw yield under the treatment R_4 were up to the tune of 26.0 and 25.6, 19.6 and 17.9 and 10.2 and 10.1 per cent higher over the treatments control (R_0), FYM @10 t/ ha (R_5) and WSI @ 5 t/ ha at 30 DBS (R_1), respectively. The marked increase in grain and straw yield of wheat were might be due to mineralization of nutrients and the enrichment of soil fertility through the incorporation of wheat straw @ 5 t ha^{-1} along with the application of 20 kg N and 20 kg P_2O_5 /ha at 30 DBS (R_4) resulted in increasing the availability and uptake of nutrients and their cumulative effect in the improvement of growth and yield attributes, such as plant height, number of effective ear heads m^{-2}, length of ear head and test weight. Significantly, the lowest grain and straw yield of wheat was recorded under the control treatment (R_0) (Table 1). This might be due to besides inadequate supply of nutrients, poor root proliferation and physico-chemical properties of soil resulted in decreased in plant height, number of effective ear heads m^{-2}, length of ear head and test weight. These findings are in close agreement with those reported by Rajput *et al.* (1992); Shinde *et al.* (1993); Velayudham *et al*. (1996); Subbaiah and Mittra (1997); Sharma and Bali (1998); Bharambe *et al*. (1999); Subrahmaniyan *et al*. (1999); Brar *et al.* (2000); Tiwari *et al*. (2000); Verma (2001); Sharma (2002); Jat *et al.* (2004) and Regar *et al*. (2005). The highest net return was obtained when wheat straw was incorporated along with 20 kg N and

Table 1 : Yield attributes and yield of wheat affected by wheat straw incorporation and levels of nitrogen (Pooled results)

Treatments	Plant height at harvest (cm)	Total chlorophyll content (mg/g)	Number of effective ear heads	Length of era heads (cm)	Test weights (g)	Grain yield (kg/ha)	Straw yield (kg/ha)	Net return (Rs./ha)
Residue management practices								
R_0: Control	95.90	1.64	348	7.01	35.14	4343	6499	25550
R_1: WSI @5t/ha at 30 DBS	101.11	1.73	368	7.29	37.28	4966	7415	26928
R_2: WSI @5t/ha + 20 kg N/ha at 30 DBS	103.14	1.76	377	7.62	38.51	5242	7792	28869
R_3: WSI @5t/ha + 20 kg P_2O_5/ha at 30 DBS	104.82	1.72	374	7.48	37.50	5060	7611	27496
R_4: WSI @5t/ha + 20 kg N and 20 kg P_2O_5/ha at 30 DBS	106.89	1.78	379	7.69	40.51	5472	8164	30536
R_5: FYM @10 t/ha	103.86	1.71	365	7.44	37.04	4576	6923	25862
C.D. (P=0.05)	4.75	0.063	14.71	0.28	2.03	202.81	298.76	
Nitrogen levels								
N_1: 60 kg N/ha	98.90	1.49	355	7.21	35.93	4514	6720	26009
N_2: 90 kg N/ha	102.95	1.75	371	7.45	37.39	4949	7432	29216
N_3: 120 kg N/ha	106.01	1.93	380	7.59	39.66	5366	8050	32247
C.D. (P=0.05)	3.36	0.045	10.40	0.20	1.47	143.41	211.25	
R x N Interaction	NS	NS	NS	NS	NS	SIG	SIG	

NS = Non-significant

20 kg P_2O_5 /ha at 30 DBS.

Different residue management treatments caused significant variation in nitrogen, phosphorus and potash content in grain and straw of wheat. Significantly the highest values of N, P_2O and K_2O content in grain and straw of wheat were recorded when wheat straw incorporation @ 5 t/ ha along with 20 kg N and P_2O_5 at 30 DBS (R_4) as compared to control (R_0). This may be because of the fact that inorganic fertilizer of N and P_2O_5 application along with residue reduced the C:N ratio of incorporated wheat straw, which favours faster mineralization and helps in release of organically bound N, P_2O_5 and K_2O, thus, increased the availability of nutrients to crop plants. The lowest nitrogen, phosphorus and potash content in wheat grain and straw under control (R_0) treatment could be attributed to lower amount of organically and inorganically nutrients added into soil, thus low amount of nutrients are available to crop plant.

The uptake of N, P_2O_5 and K_2O by grain and straw of wheat at harvest were influenced significantly due to residue management practices. Wheat straw incorporation @ 5 t/ ha along with 20 kg N and 20 kg P_2O_5 /ha at 30 DBS (R_4) was recorded remarkably higher nitrogen, phosphorus and potash uptake by grain and straw of wheat as compared to all other treatments. Significant increase in nutrients uptake could be due to irrespective increase in nutrient concentration of grain and straw as well as increase in total dry matter production. The finding of Rajput *et al*. (1992); Subbaiah and Mittra (1997); Sharma and Bali (1998); Bharambe *et al.* (1999); Sharma *et al*. (2000a); Sharma *et al.* (2000b); Surya *et al*. (2000) and Tiwari *et al*. (2000) also supported the results of the present study.

Effect of nitrogen :

Difference in growth and yield attributes and yield of wheat were found significant due to different doses of N application. Application of higher levels of N (120 kg/ ha) was found significantly higher plant height, total chlorophyll content at 30 DAS, test weight, number of effective ear heads per plant and length of ear head over 60 kg N ha^{-1}. The per centage increase of plant height at harvest, number of effective ear head m^2, length of ear head and test weight were up to the tune of 7.1, 7.03, 5.3 and 10.4 per cent under the treatment N_3 over N_1. The increase in all these yield attributes were might be ascribed to supply of nitrogen at higher levels increase photosynthetic activities and translocation of photosynthates, which might have promoted the growth, better partitioning of photosynthates in yield attributes and eventually produced large size of ear head, as well as more grain of higher weight that ultimately increased

Table 2 : Nutrients content in grain and straw of wheat as affected by different residue management practices and nitrogen levels

(Pooled results)

Treatments	N content (%)		P content (%)		K content (%)	
	Grain	Straw	Grain	Straw	Grain	Straw
Residue management practices						
R_0 :Control	1.74	0.46	0.36	0.18	0.35	0.69
R_1: WSI@ 5t/ha at 30 DBS	1.89	0.49	0.37	0.18	0.36	0.73
R_2: WSI@ 5 t/ha +20 kg N/ha at 30 DBS	1.93	0.50	0.38	0.19	0.37	0.74
R_3: WSI@ 5 t/ha +20 kg P_2O_5/ha at 30 DBS	1.88	0.51	0.38	0.19	0.38	0.74
R_4: WSI@ 5 t/ha +20 kg N and 20 kg P_2O_5/ha at 30 DBS	1.93	0.53	0.39	0.20	0.40	0.75
R_5 :FYM 10 t/ha	1.83	0.49	0.37	0.19	0.37	0.72
S.E.±	0.030	0.011	0.006	0.003	0.008	0.011
C.D. (P=0.05)	0.085	0.031	0.016	0.008	0.022	0.032
Nitrogen levels						
N_1 : 60 kg N/ha	1.72	0.47	0.36	0.17	0.33	0.69
N_2 : 90 kg N/ha	1.85	0.50	0.38	0.19	0.37	0.74
N_3 : 120 kg N/ha	2.03	0.53	0.38	0.21	0.41	0.76
S.E.±	0.021	0.008	0.004	0.002	0.005	0.008
C.D. (P=0.05)	0.060	0.022	0.012	0.006	0.015	0.023
R×N Interaction	NS	NS	NS	NS	NS	NS
C.V. (%)	6.86	9.46	6.57	6.40	8.74	6.68

NS = Non–significant

the yield. Similar results on yield attributes were also reported by Malik (1981); Singh *et al.* (1992); Patel and Upadhyay (1993); Singh *et al.* (1996); Kataria *et al.* (1999); Shivakumar and Mishra (2001); Kibe and Singh (2003) and Singh *et al.* (2003).

The application of graded levels of N register linear and significantly increase in grain and straw yields of wheat. Grain and straw yields of wheat were produced significantly the highest with the application of 120 kg N/ ha over 60 and 90 kg N/ ha. The magnitude of grain and straw yield increased owning to direct application of N with 120 kg /ha to wheat were 18.9 and 8.4 and 19.8 and 10.6 per cent over 60 and 90 kg N ha^{-1}, respectively. Possible increase of grain yield at higher level of nitrogen was ascribed to overall improvement in yield attributing characters such as effective ear heads m^{-2} ear head length and test weight. The increased supply of nitrogen helped in faster cell division and multiplication, there by increased plant height and ultimately stover yield. Similar positive results of higher rates of nitrogen application on grain and straw yields were also reported by Dhuka *et al.* (1992); Singh *et al.* (1992); Patel and Upadhyay (1993); Singh *et al.* (1996); Upadhyay and Tiwari (1996); Pandey *et al.* (1997); Singh *et al.* (1997); Kataria *et al.* (1999); Kumar *et al.* (2001); Shivakumar and Mishra (2001); Sardana *et al*. (2002); Sharma and Manohar (2002); Kibe and Singh (2003) and Singh *et al.* (2003).

The data given in Table 2 clearly indicated that nitrogen, phosphorus and potash content in wheat grain and straw were significantly increased with successive increase in nitrogen application. The concentration of N, P_2O_5 and K_2O in grain and straw of wheat were obtained significantly highest under the application of 120 kg N/ ha and lowest under 60 kg N/ ha. It is commonly observed that higher level of nitrogen application provides congenial surrounding for better root growth and distribution. This enhances the scope to explore the nutrients from the greater soil volume. The results confirm the finding of Waliya *et al.* (1980); Rao and Bharadwaj (1981) and Parihar and Tripathi (1989).

Application of nitrogen did exert significant variation in nutrients uptake by grain and straw of wheat. The uptake of nitrogen, phosphorus and potash by grain and straw were obtained significantly higher due to application of 120 kg N/ ha (N_3) over 60 kg N/ ha (N_1). There was an increase about 39.9 and 34.4 per cent nitrogen uptake, 23.9 and 50.9 per cent phosphorus uptake and 50.3 and 31.1 per cent potash uptake by grain and straw, respectively, under N_3 treatment over N_1 treatment. The increased uptake of these nutrients could be due to the concentration of respective nutrients were increased in grain and straw as well as grain and straw yields also higher

Table 3 : Nutrients uptake by grain and straw of wheat as affected by different residue management practices and nitrogen levels

(Pooled results)

Treatments	N uptake (kg/ha)		P_2O_5 uptake (kg/ha)		K_2O uptake (kg/ha)	
	Grain	Straw	Grain	Straw	Grain	Straw
Residue management practices						
R_0 : Control	76.28	30.42	15.65	11.56	15.18	45.20
R_1 : WSI@ 5t/ha at 30 DBS	93.98	36.74	18.33	13.35	17.84	54.10
R_2: WSI@ 5 t/ha +20 kg N/ha at 30 DBS	101.38	39.33	19.90	14.69	19.57	57.66
R_3 : WSI@ 5 t/ha +20 kg P_2O_5/ha at 30 DBS	95.47	38.66	19.31	14.77	19.43	56.04
R_4 :WSI@ 5 t/ha +20 kg N and 20 kg P_2O_5/ha at 30DBS	106.14	43.13	21.17	16.29	21.98	61.43
R_5 :FYM 10 t/ha	84.34	34.30	16.98	13.22	16.97	50.20
S.E.±	2.138	0.949	0.371	0.251	0.469	1.289
C.D. (P=0.05)	6.03	2.679	1.046	0.707	1.325	3.638
Nitrogen levels						
N_1 : 60 kg N/ha	77.82	31.67	16.53	11.22	14.82	46.50
N_2 : 90 kg N/ha	92.07	37.05	18.66	13.78	18.39	54.82
N_3 : 120 kg N/ha	108.91	42.57	20.48	16.94	22.27	61.00
S.E.±	1.512	0.671	0.262	0.177	0.332	0.912
C.D. (P=0.05)	4.266	1.894	0.740	0.500	0.937	2.573
R×N Interaction	NS	NS	Sig	Sig	NS	NS
C.V. (%)	9.76	10.86	8.47	7.60	10.77	10.11

NS = Non – significant

in the same treatments (Table 3). Similar findings were also observed by of Waliya *et al.* (1980); Rao and Bharadwaj (1981); Dhuka *et al.* (1992) and Singh *et al.* (1996).

Conclusion :

Incorporation of wheat straw @ 5 t/ ha + 20 kg N + 20 kg P_2O_5/ha at 30 days before sowing and application of 120 kg N/ha obtained highest yield of wheat (GW-496), net return and reduce phosphorus requirement (40 kg P_2O_5/ha) of the crop and also increase the different nutrient content and uptake.

REFERENCES

Bharambe, P.R., Patil, M.A., Oza, S.R. and Shelke, D.K. (1999). Effect of crop residue incorporation and irrigation on sunflower yield and soil productivity under sorghum-sunflower cropping system. *J. Indian Soc. Soil Sci.*, **47**(1) : 169-171.

Brar, S.S., Kumar, S. and Narang, R.S. (2000). Effect of moisture regime and nitrogen on decomposition of combined harvested rice residue and performance of succeeding wheat in rice-wheat system in Punjab. *Indian J. Agron.*, **45**(3) : 458-462.

Das, K., Medhi, D.N. and Guha, B. (2001). Recycling effect of crop residues with chemical fertilizer on physico-chemical properties of soil and rice yield. *Indian J. Agron.*, **46**(4) : 648-653.

Dhuka, A.K., Sadaria, S.G., Patel, J.C. and Patel, B.S. (1992). Effect of seed rate and time of nitrogen application on late sown wheat. *Indian J. Agron.*, **37**(2) : 354-355.

Hemalatha, M., Thirumurugan, V., Joseph, M. and Balasubramanian, R. (2000). Acceleration of decomposition of paddy straw through bacteria, fertilizer amendments and its influence on growth and yield of rice. *J. Maharastra Agric. Univ.*, **25**(3) : 267-269.

Jat, M.L., Pal, S.S., Shukala, L., Mathur, J.M.S. and Singh, M. (2004). Rice residue management using cellulolytic fungi and its effects on wheat yield and soil health in rice-wheat cropping system. *Indian J. Agric. Sci.*,**74** (3):117-120.

Kataria, N., Bassi, K. and Kataria, R.K. (1999). Response of wheat to nitrogen and mulch application under rainfed conditions. *Indain J. Agron.*, **44** (1): 115-118.

Kibe, A.M. and Singh, S. (2003). Influences of irrigation, nitrogen and zinc on productivity and water use by late sown wheat. *Indian J. Agron.*, **48**(3) : 186-191.

Kumar, V., Behl, R.K. and Narula, N. (2001). Effect of phosphate solubilizing strains of *Azotobacter chroococcum* on yield traits and their survival in the rhizosphere of wheat genotypes under field conditions.*Acta Agron. Hung.*, **49**: 141-149.

Malik, C.V.S. (1981). Response of wheat varieties to different levels of nitrogen. *Indian J. Agron.*, **26**(1) : 93-94.

Pandey, D.S., Kumar, D., Misra, R. D., Prakash, A. and Gupta, V.K. (1997). An integrated approach of irrigation and fertilizer management to reduce lodging in wheat (*Triticum aestivum*). *Indian J. Agron.*, **42** (1) : 86-89.

Parihar, S.S. and Tripathi, R.S. (1989). Response of wheat to nitrogen, irrigation and sowing dates. *Indian J. Agron.*, **34**(2) : 255-256.

Patel, R.M. and Upadhyay, P.N. (1993). Response of wheat to irrigate under varying levels of nitrogen and phosphorus. *Indian J. Agron.*, **38**(1) : 113-115.

Rajput, A.L., Warsi, A.S. and Verma, L.P. (1992). Residual effect of organic material and nitrogen levels on wheat grown after rice. *Indian J. Agric. Sci.*, **37**(4) : 783-784.

Rao, Y.G. and Bharadwaj, R.B.L. (1981). Correlation studies in wheat. *Indian J. Agron.*, **25**(2) : 198-199.

Regar, P.L., Rao, S.S. and Vyas, S.P. (2005). Crop residue management for increased wheat production under saline soil of arid fringes. *Indian J. Agric. Sci.*, **75**(2) : 83-86.

Sardana, V., Sharma, S.K. and Randhawa, A.S. (2002). Yield performance of wheat (*Triticum aestivum* L.) varieties to late and very late sowing dates under the extreme north-west conditions of Punjab. *J. Res. Punjab Agric Univ.*, **40** : 177-182.

Sharma, M.P. and Bali, S.V. (1998). Effect of rice residue management in wheat yield and soil properties in rice-wheat cropping system. *Indian J. Agric. Sci.*, **68**(10) : 695-696.

Sharma, M.P., Bali, S.V. and Gupta, D.K. (2000a). Crop yield and properties of Inceptisol as influenced by residue management under rice-wheat cropping sequence. *J. Indian Soc. Soil Sci.*, **48**(3) : 506-509.

Sharma, P.K., Mishra, B.S., Singh, Y.H. and Chaudhary, D.C. (2000b). *Managing natural resource for sustainable agricultural production in the 21st century. Extended Summaries*. International conference, IARI, New Delhi, **2** : 894-895.

Sharma, P.N. and Manohar, S.S. (2002). Response of wheat (*Triticum aestivum*) to nitrogen and sulphur and their residual effect on succeeding pearlmillet (*Pennisetum glaucum*). *Indian J. Agron.*, **47**: 473-476.

Sharma, S.N. (2002). Nitrogen management in relation to wheat (*Triticum aestivum* L.) residue management in rice (*Oryza sativa* L.). *Indian J. Agric. Sci*., **72**(8) : 449-452.

Shinde, D.B., Navale, A.M. and Jadhav, S.B. (1993). A study on incorporation of sugarcane trash in ratoon sugarcane. *J. Maharashtra Agric. Univ.*, **18**(2) : 264-265.

Shivakumar, B.G. and Mishra, B.N. (2001). Effect of land configuration, nutrient and stover management on growth and yield of wheat under limited water supply. *Ann. Agric. Res.*, **22**(4) : 462-467.

Singh, G., Singh, R. and Kumar, P. (1996). Response of wheat to nitrogen, phosphorus and potassium fertilization. *Indian J. Agron.*, **41**(1) : 157-159.

Singh, R.P., Dabas, S., Choudhary, A. and Maheshwari, R. (1997). Effect of lead on nitrate reductase activity and alleviation of lead toxicity by inorganic salts and 6-benzylaminopurine. *Biol. Plant.*, **40** : 339-404 .

Singh, R.V., Dubey, V.K. and Vyas, M.D. (1992). Effect of seed rate, nitrogen levels and method of fertilizer placement on wheat under late sown condition. *Indian J. Agron*., **37**(1) : 43-46.

Singh, V., Bhunia, S.R. and Chauhan, R.P.S. (2003). Response of late sown of wheat to row spacing-cum-population densities and levels of nitrogen and irrigation in north-western Rajasthan. *Indian J. Agron*., **48**(3) : 186-191.

Subbaiah, G. and Mittra, B.N. (1997). Effect of varying rate and time of incorporation of crop residue with and without phosphorus in rice. *Andhra Agric. J*., **44** (3 & 4): 153-155.

Subrahmaniyan, K., Kalaiselvan, P. and Arulmozhi, N. (1999). Nutrient management in groundnut based cropping system. *Leg. Res*., **22** (2): 124-126.

Surya, J.N., Puranik, R.B., Zadode, S.D. and Deshmukh, S.D. (2000). Effect of wheat straw incorporation on yield of green gram and wheat, soil fertility and micro-biota. *J. Maharashtra agric. Univ*., **25** (2): 158-160.

Tiwari, V. N., Tiwari, K.N. and Upadhyay, R.M. (2000). Effect of crop residue management and bio-gas slurry incorporation in wheat on yield and soil fertility. *J. Indian Soc. Soil Sci.*, **48** (3): 515-520.

Upadhyaya, V.B. and Tiwari, J.P. (1996). Influence of nitrogen, seed rate and mulch on wheat (*Triticum aestivum*) varieties under late sowed conditions. *Indian J. Agron.*, **41** (4) : 562-565.

Velayudham, K., Arunachalam, A.A., Veerabadran, V., Manoharan, S. and Balasubramanian, R.C. (1996). Effect of organic waste on growth and yield of wheat. *Indian J. Agron.*, **41**(4) : 584-585.

Verma, K.P. (2001). Effect of crop residue incorporation and nitrogen on succeeding wheat. *Indian J. Agron*., **46**(4) : 665-669.

Waliya, R.S., Singh, R. and Singh, Y. (1980). Growth and nutrient uptake behaviours of dry land wheat as influenced by nitrogenous fertilization. *J. Indian Soc. Soil Sci*., **28** (1) : 91-97.