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GROWTH, YIELD AND NUTRIENTS CONTENT AND UPTAKE BY GRAIN AND STRAW OF WHEAT AS AFFECTED BY DIFFERENT RESIDUE MANAGEMENT PRACTICES AND NITROGEN LEVELS

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ABSTRACT
An experiment was conducted 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 randomize block design replicated thrice. Growth and yield attributes of wheat were increased due to different residue management treatments and FYM over control. However, addition of wheat straw @ 5 t ha^{-1} along with 20 kg N and 20 kg P_2O_5 ha^{-1} 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 under 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 yield of wheat. Similarly, nitrogen, phosphorus and potash content and uptake by grain and straw of wheat were recorded significantly highest under the same treatment.

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 fertilitywell (Singh *et al.*, 1996). 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. Burning of crop residues is not only a source of atmospheric pollution, but also loss of precious plant nutrients and valuable renewable organic matter resources (Ponnamperuma, 1984). 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. Goswami and Rattan (1992) reported that continuous use of high analysis fertilizer without the supplementation of organic matter accelerated the pace of depletion of secondary and micro-nutrients. Thus, optimum combination of organic and inorganic fertilizer added in soil in order to improve the efficiency and economy of applied nitrogen with concomitant improvement in the soil fertility and productivity.

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".

MATERIALS AND METHODS

A field experiment was conducted at College Agronomy Farm, Anand Agricultural University, Anand, (22^0-35' N and 72^0-55' 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^{-1} + 20 kg N ha^{-1} at 30 DBS, R_3: WSI @ 5 t ha^{-1} + 20 kg P_2O_5 ha^{-1} at 30 DBS, R_4: WSI @ 5 t ha^{-1} + 20 kg N plus 20 kg P_2O_5 ha^{-1} at 30 DBS and

R_5: FYM @ 10 t ha^{-1} two DBS) and three levels of nitrogen application (N_1: 60 kg N ha^{-1}, N_2: 90 kg N ha^{-1} and N_3: 120 kg N ha^{-1}) 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^{-1} 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 sprayed 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. Representative samples of grain and straw were taken from each plot for chemical analysis after harvest of crop. Estimation of total nitrogen, phosphorus and potash content in grain and strawwas done by modified Kjeldahl's method, Vanadomolybdo phosphoric acid yellow colour method and acid extract by Flame photometric method as described by Jackson (1973), respectively.

RESULTS AND DISCUSSION

Effect of residue managements practices

The addition of wheat straw with or without inorganic fertilizer or application of FYM @ 10 t ha^{-1} alone remarkably influenced the all the growth and yield attributing characters. Significantly the highest plant height at harvest,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^{-1} FYM alone. Incorporation of wheat straw @ 5 t ha^{-1} at 30 DBS alone and wheat straw @ 5 t ha^{-1} along with 20 P_2O_5 ha^{-1} at 30 DBS remained at par in respect of grain and straw yields of wheat. Similarly, addition of wheat straw @ 5 t ha^{-1} plus 20 kg N ha^{-1} 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^{-1}) of wheat were obtained under the incorporation of wheat straw @ 5 t ha^{-1} plus 20 kg N and 20 kg P_2O_5 ha^{-1} 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^{-1} (R_5) and WSI @ 5 t ha^{-1} 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^{-}

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

Treatments	Plant height at harvest (cm)	Total chlorophyll content (mg/g)	No. of effective ear heads	Length of era heads (cm)	Test weights (g)	Grain yield (kg/ha)	Straw yield (kg/ha)
Residue Management Practices							
R_0: Control	95.90	1.64	348	7.01	35.14	4343	6499
R_1: WSI @5t/ha at 30 DBS	101.11	1.73	368	7.29	37.28	4966	7415
R_2: WSI @5t/ha + 20 kg N/ha at 30 DBS	103.14	1.76	377	7.62	38.51	5242	7792
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
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
R_5: FYM @10 t/ha	103.86	1.71	365	7.44	37.04	4576	6923
CD (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
N_2: 90 kg N/ha	102.95	1.75	371	7.45	37.39	4949	7432
N_3: 120 kg N/ha	106.01	1.93	380	7.59	39.66	5366	8050
CD (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

Table 2: Nutrients content in grain and straw of wheat as affected by different residue management practices and nitrogen levels (pooled results o two year)

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_2Os/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_2Os/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
5 Em. I	0.030	0.011	0.006	0.003	0.008	0.011
CD at 5%	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
5 Em.I	0.021	0.008	0.004	0.002	0.005	0.008
CD at 5%	0.060	0.022	0.012	0.006	0.015	0.023
RXN Interaction	NS	NS	NS	NS	NS	NS
CV %	6.86	9.46	6.57	6.40	8.74	6.68

Table 3: Nutrients uptake by grain and straw of wheat as affected by different residue management practices and nitrogen levels (pooled results of two year)

Treatments	N uptake (kg/ha)		P_2Os 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_2Os/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_2Os/ha at 30 DBS	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
5 Em. I	2.138	0.949	0.371	0.251	0.469	1.289
CD at 5%	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
5 Em.I	1.512	0.671	0.262	0.177	0.332	0.912
CD at 5%	4.266	1.894	0.740	0.500	0.937	2.573
RXN Interaction	NS	NS	Sig	Sig	NS	NS
CV %	9.76	10.86	8.47	7.60	10.77	10.11

[1] 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). 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 20 kg P_2O_5 ha^{-1} 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^{-1} 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^{-1} along with 20kg N and 20 kg P_2O_5 ha^{-1} 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^{-1}) 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 percentage 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 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 b), Kataria *et al.* (1999), Shivakumar and Mishra (2001), Kibe and Singh (2003), Singh *et al.* (2003) and Mishra (2012).

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^{-1} over 60 and 90 kg N ha^{-1}. The magnitude of grain and straw yield increased owning to direct application of N with 120 kg ha^{-1} 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), Sharma *et al.* (2000c), Kumar *et al.*(2001), Shivakumar and Mishra (2001), Sardana *et al.* (2002), Sharma and Manohar (2002), Kibe and Singh (2003), Sen *et al.* (2003), Singh *et al.* (2003) and Verma and Baigh (2012).

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^{-1} and lowest under 60 kg N ha^{-1}. 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 (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^{-1} (N_3) over 60 kg N ha^{-1} (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 in the same treatments. Similar findings were also observed by of Waliya *et al.* (1980), Rao and Bharadwaj (1981), Dhuka *et al.* (1992) and Singh *et al.* (1996).

It is therefore concluded that incorporation of wheat straw @ 5 t ha^{-1} + 20 kg N + 20 kg P_2O_5 ha^{-1} at 30 days before sowing and application of 120 kg N ha^{-1} obtained highest yield of wheat (GW-496), net return and reduce phosphorus requirement (40 kg P_2O_5 ha^{-1}) of the crop and also increase the different nutrient content and uptake.

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