Original Research Article

QUALITY OF BREAD WHEAT (*Triticum aestivum* L.) AS INFLUENCED BY DIFFERENT NUTRIENT MANAGEMENT APPROACHES UNDER NORTHERN TRANSITIONAL ZONE OF KARNATAKA

ABSTRACT

The field experiments were conducted at the Research Farm of AICW&BIP, Main Agricultural Research Station, University of Agricultural Sciences, Dharwad during *rabi* 2020-21 and 2021-22 and was laidout in Randomized Complete Block Design with 15 treatments replicated thrice to evaluate the performance of wheat quality to various nutrient management approaches. The pooled data of two years indicated that the yield target at 55 q ha^{-1} under SSNM practice significantly increased the protein content (13.43 %), wet gluten (34.7 %), dry gluten (11.9 %), gluten index (81.6 %), sedimentation value (46.3 ml) and yellow pigment (5.93 ppm) in wheat grain and it was found on par with yield targets at 50 and 45 q ha^{-1} under SSNM.

Key words: *Quality, SSNM, STCR, STL, Targeted yield, Wheat*

1. INTRODUCTION

Wheat (*Triticum aestivum* L.) is popularly known as the king of cereals. It is the second most important cereal crop after rice in India and it belongs to family poaceae. Wheat is an important source of carbohydrates. Globally, it is the leading source of vegetable protein in human food, having a protein content of about 13 per cent, which is relatively high compared to other major cereals but relatively low in protein quality for supplying essential amino acids, but it is a good source of multiple nutrients (i.e. Phosphorous, Magnesium, Niacin, Iron and Calcium) and dietary fiber. It provides a balanced food to millions of people.

Wheat ranks first in the area and production at global level, and India is the second largest wheat producer in the World followed by China. In India, the wheat is grown over an area of 31.35 million hectare with annual production of 107.86 million tones and productivity of 3440 kg ha^{-1} (Anon., 2021). In Karnataka, wheat is grown over an area of 1.50 million hectare with the production of 1.63 million tones and productivity of 1198 kg ha^{-1} (Anon., 2021).

In India wheat is ground to prepare flour which is mainly consumed after preparing leavened bread (chapati). Its flour is also used to prepare fried chapatti called ‘puris’ and ‘paratha’. In addition to this, wheat is also consumed in various other preparations such as ‘dalia’, ‘halwa’, ‘sweat meal’ etc. One of the most important uses of wheat is to manufacture flour to prepare baking bread, pastry, biscuits etc.

Nowadays, farmers are trying to get high grain yields in line with food quality, at the same time trying to minimize production costs and to use environmental friendly technologies. Nowadays, not only yield but also the quality of the produced grain is important, because the quality of the grains determines their direction of use (Jin *et al*., 2016). That is why farmers are trying to get high grain yields in line with food (accepted for bread baking) quality, while minimize production costs and using environmentally-friendly technologies. Among them balanced nutrition plays an important role in physiological and biochemical processes of plant in determining the yield as well as the quality of produce. In this regard, Soil Test Laboratory (STL), Site Specific Nutrient Management (SSNM), Soil Test Crop Response (STCR) and Nutrient Expert (NE) approaches are unique in the sense that these methods not only indicate soil test based fertilizer dose but also the level of yield the farmer can hope to achieve if good nutrient management practices are followed in raising the crop. Hence, the present investigation is proposed with the objective to evaluate the effect of different fertilizer recommendation approaches on the quality of *irrigated* wheat.

2. MATERIAL AND METHODS

The field experiments were conducted at Research Farm of All India Co-ordinated Wheat and Barley Improvement Project (AICW&BIP), Main Agricultural Research Station, University of Agricultural Sciences, Dharwad during *rabi* 2020-21 and 2021-22 under *irrigated* condition. The study area was located in Northern Transition Zone (Zone VIII) of Karnataka and is situated at 15^0 26' North latitude, 75^0 07' East longitude and at an altitude of 678 m above mean sea level (MSL). The wheat variety used for the experiment was UAS-334 (Bread wheat). The initial soil properties are presented in Table 1.

Table 1: Initial soil properties

Sl. No.	Particulars	Values	Method
1.	Textural class	Clay loam	
2.	Soil reaction (1:2.5, soil water suspension)	7.67	Potentiometric method
3.	Electrical conductivity (1:2.5, soil water extract) (dS m^{-1})	0.26	Conductometric method
4.	Organic carbon (%)	0.68	Walkley and Black’s wet oxidation method
5.	Free calcium carbonate (g kg^{-1})	5.42	Rapid acid neutralization method
6.	Available N (kg ha^{-1})	176.9	Modified alkaline permanganate method
7.	Available P_2O_5 (kg ha^{-1})	33.77	Olsen’s method of extraction followed by Spectrophotometric method

8.	Available K_2O (kg ha^{-1})	361.68	Neutral Normal Ammonium acetate extraction followed by Flame photometric method
9.	Available S (kg ha^{-1})	25.63	0.15% $CaCl_2$. 2 H_2O extraction followed by Turbidimetry
10.	DTPA - extractable micronutrients (mg kg^{-1})		DTPA extraction followed by Atomic absorption spectrophotometric method
a.	Copper	0.58	
b.	Iron	4.34	
c.	Manganese	6.18	
d.	Zinc	0.51	

Table 2. : Treatment details and quantity of fertilizers applied

Treatment details		**Quantity of fertilizers applied (kg ha^{-1})**		
		N	**P_2O_5**	**K_2O**
T_1	Absolute control	-	-	-
T_2	RDF	100	75	50
T_3	RPP	100	75	50
T_4	125% RDF	125	93.75	62.5
T_5	150% RDF	150	112.5	75
T_6	STL based NPK application	125	75	25
T_7	SSNM yield target @ 40 q ha^{-1}	200.4	29.33	98.4
T_8	SSNM yield target @ 45 q ha^{-1}	225	33	110.4
T_9	SSNM yield target @ 50 q ha^{-1}	250	36.67	123.2
T_{10}	SSNM yield target @ 55 q ha^{-1}	275	40.33	135.2
T_{11}	STCR yield target @ 40 q ha^{-1}	170.7	0.0	20.04
T_{12}	STCR yield target @ 45 q ha^{-1}	208.4	0.0	32.49
T_{13}	STCR yield target @ 50 q ha^{-1}	246.1	0.0	44.94
T_{14}	STCR yield target @ 55 q ha^{-1}	283.8	7.25	57.39
T_{15}	Nutrient Expert yield target @ 40 q ha^{-1}	80	53	45

The chemical fertilizers were applied as per treatments. Recommended nitrogen, phosphorus and potassium were applied through urea, single super phosphate (SSP) and muriate of potash (MOP), respectively. Recommended Fe and Zn were applied in the form of iron sulphate and zinc sulphate. The entire quantity of fertilizer mixture containing entire dose of phosphorus, potassium, iron sulpahte and zinc sulphate were applied to each plot at the time of sowing. Crude protein content in wheat grain was determined by multiplying nitrogen concentration in grain by 5.70 and expressed in per cent. The sedimentation value and yellow pigment in wheat grain was analyzed by following standard analytical procedure as described by Mishra and Gupta (1995). Gluten parameters were determined according to standard AACC methods. It was done by using gluten washer (Erkaya, GW 2200®, Ankara, Turkey). Ten gram wheat flour samples were analyzed for wet gluten (WG), dry gluten (DG) and gluten index (GI). The following formula was used to calculate the gluten index.

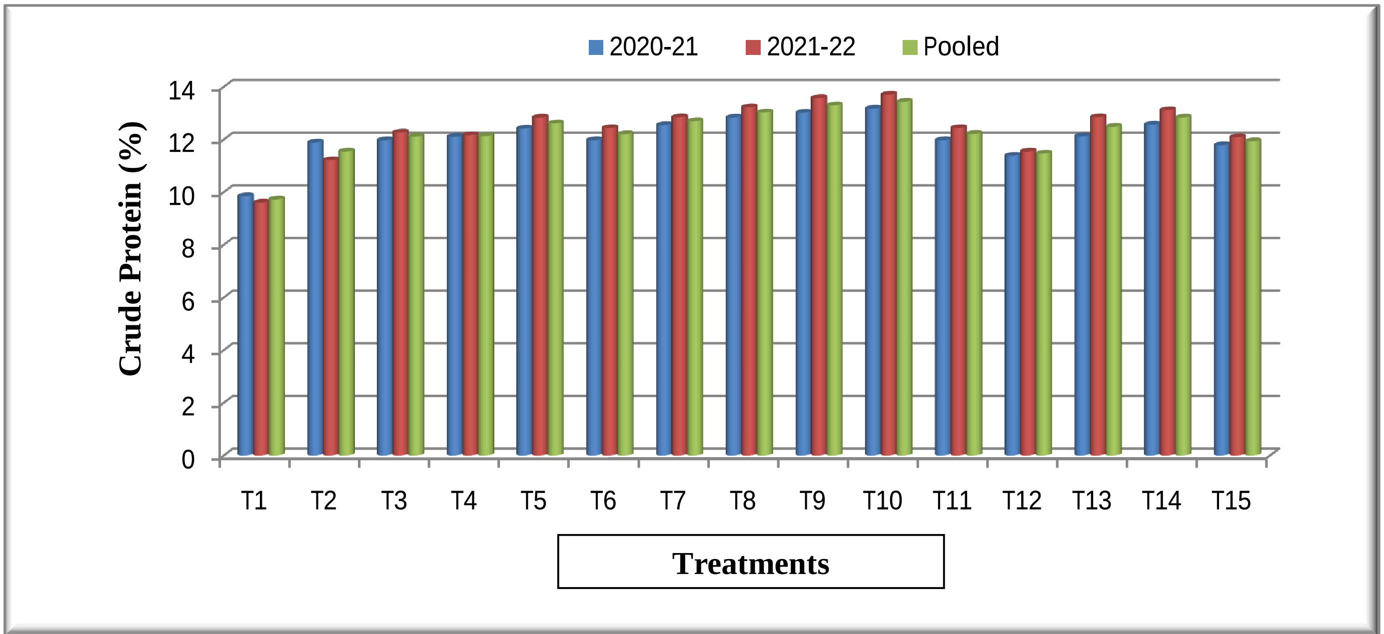
$$\text{Gluten index (GI)} = \frac{\text{Wet gluten remained on sieve (g)}}{\text{Total wet gluten (g)}} \times 100$$

3. RESULTS AND DISCUSSION

3.1 Crude protein content:

Among the quality traits, grain protein content in wheat has received special attention as a conventional indicator for measuring the nutritional value of food (Zhao *et al*., 2010). Among the different treatments, T_{10}: yield target at 55 q ha^{-1} under SSNM approach recorded higher protein content (13.43 %) in wheat grain and was statistically on par with yield targets of 50 (T_9) (13.29 %) and 45 q ha^{-1}(T_8)(13.02 %) under the said practice but these treatments were significantly superior to the remaining treatments (Table 3 and Fig. 1). The crude protein content in wheat grain during individual years ranged from 9.84 (T_1) to 13.17 per cent (T_{10}) in 2020-21 and 9.60 (T_1) to 13.70 per cent (T_{10}) in 2021-22 and the effect of different fertilizer recommendation practices on crude protein content in wheat grain was similar to pooled analysis. The increase in the grain protein content in wheat grain in the said treatments might be due to more nitrogen accumulation in the plants (Singh, 2017). Nitrogen being the precursor of protein increased it's content in grain (Dinesh and Dashrath, 2017). Sunil *et al*. (2018) also found that protein content in wheat grain was significantly higher with SSNM approach of fertilizer recommendation to crops in rice-wheat cropping sequence followed by STCR approach of fertilizer recommendation and graded levels of fertilizer application. Increasing levels of nitrogen application significantly increased the grain protein content in wheat (Halverson *et al*., 2004). The increase in protein content in wheat grain under higher nitrogen application rates might be attributed to the higher N supply that favors the conversion of carbohydrates into proteins, which in turn promotes the formation of protoplasm resulting in translocation of more nitrogen to grains and ultimately increasing the grain protein content (Zemichael *et al*., 2017). The results were in conformity with Majid *et al.* (2010), Haile *et al*. (2012) and youssef *et al*. (2013) in wheat.

Fig. 1: Crude protein content as influenced by various nutrient management approaches



3.2 Gluten content:

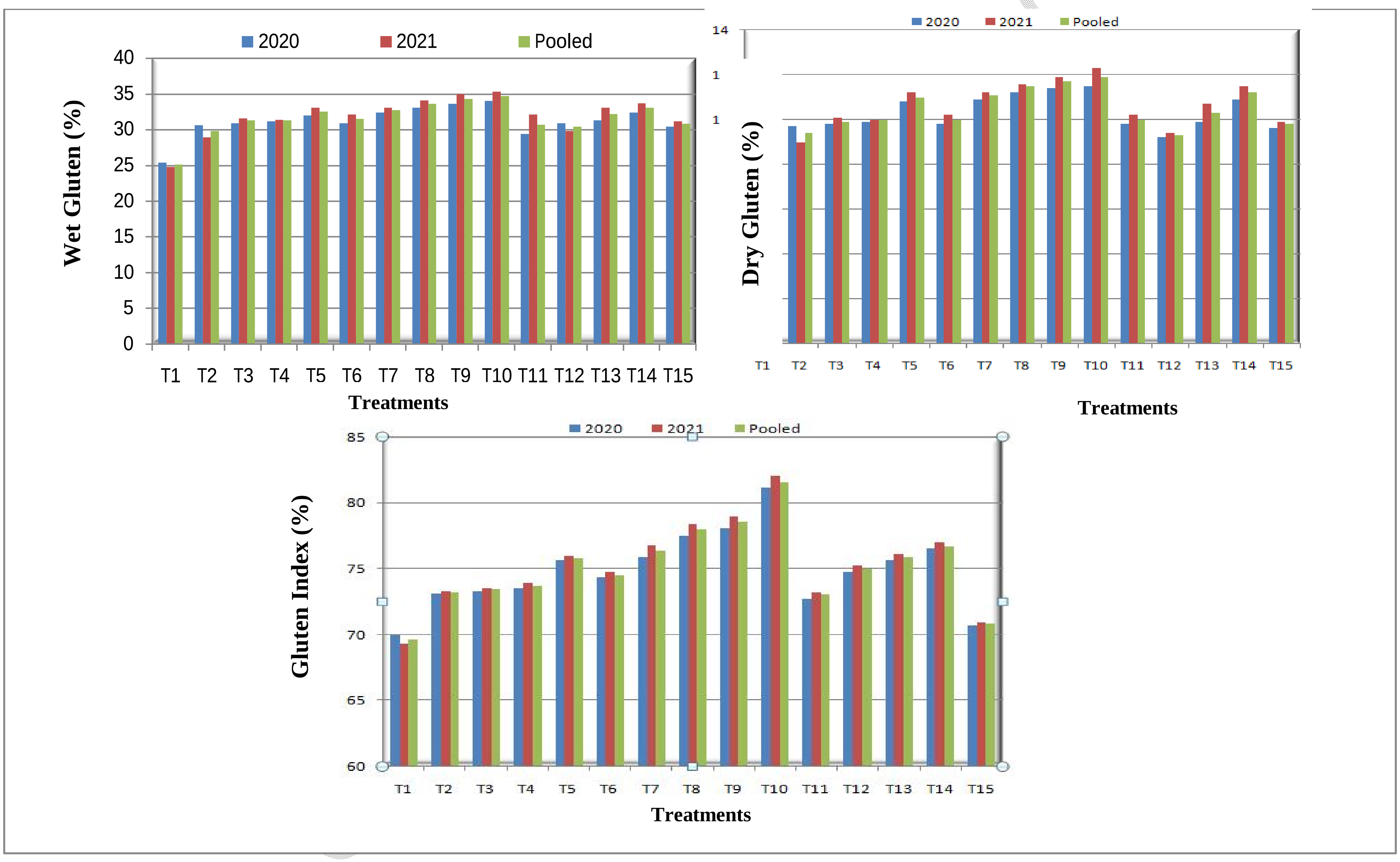
According to the solubility of protein components in different solvents, wheat protein can be divided into gliadin, glutenin, albumin and globulin (Singh and Skerritt, 2001). Among them, gliadin and glutenin are the main storage proteins of wheat, and the main constituents of wet gluten. The wet and dry gluten contents and gluten index composition affect the viscoelasticity and baking quality of wheat dough (Torbica *et al*., 2007). Water retention capacity, loaf volume and dough strength of bread are functions of gluten.

The higher wet (34.7 %) and dry (12.3 %) gluten contents and gluten index (81.6 %) in wheat grain was observed in target yield of 55 q ha^{-1} (T_{10}) and was on par with yield targets at 50 (T_9) and 45 q ha^{-1} (T_8) the same practice of nutrient management but significantly superior to rest of the treatments (Table 4 and Fig. 2). The wet gluten content in wheat flour during individual years ranged from 25.4 (T_1) to 34.0 per cent (T_{10}) in 2020-21 and 24.8 (T_1) to 35.3 per cent (T_{10}) in 2021-22. Similarly, dry gluten content in wheat flour was similar in both the individual years and the value ranged from 7.7 (T_1) to 11.5 per cent (T_{10}) during 2020-21 and 7.5 (T_1) to 12.3 per cent (T_{10}) during 2021-22. The gluten index in wheat grain during individual years ranged from 69.9 (T_1) to 81.2 per cent (T_{10}) in 2020-21 and 69.3 (T_1) to 82.1 per cent (T_{10}) in 2021-22. This is because of higher protein content in wheat grain in the above said treatments, as there is synergetic relation between wheat grain protein and gluten contents. This is also attributed to application of nitrogen in adequate quantity as per the crop requirement which might have improved the quality of grains because nitrogen is an essential component of protein. The present results can be correlated with the findings of Litke *et al*. (2018) who opined that application of 240 kg N ha^{-1} to wheat grown in loam soil increased the protein and gluten contents from 8.7 to 13.7 per cent and 14.73 to 28.74 per cent, respectively.

3.3 Sedimentation value:

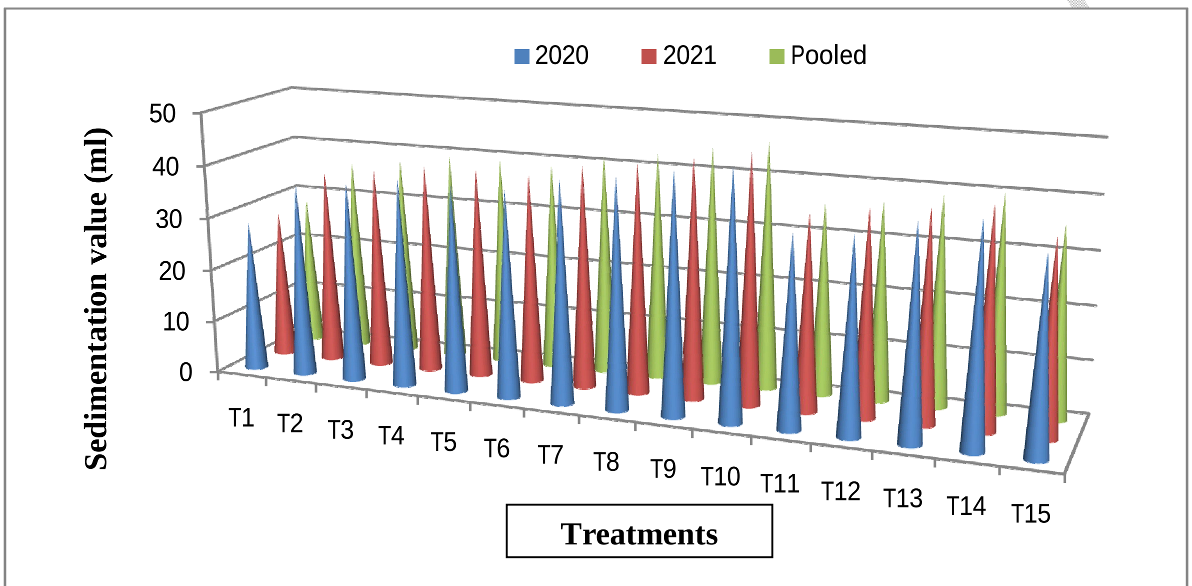
Ssdimentation value of wheat was significantly higher in T_{10}: SSNM yield targeted at 55 q ha^{-1} (46.3 ml) and was on par with 50 q ha^{-1} (T_9)(44.7 ml) under the same nutrient management practice and both of these treatments were significantly superior over rest of the treatments (Table 3 and Fig. 3). The yield target at 40 and 45 q ha^{-1} under SSNM approach recorded statistically similar sedimentation value. The impact of various fertilizer recommendation approaches on sedimentation value of wheat flour was similar in both the individual years and the values ranged from 28.3 (T_1) to 46.1 ml (T_{10}) during 2020-21 and 27.9 (T_1) to 46.5 ml (T_{10}) during 2021-22. This is because sedimentation value is a gluten dependent quality parameter and is directly related to gluten content in wheat grain. This is based on the fact that gluten protein absorbs water and swells considerably when treated with lactic acid in the presence of sodium dodecyle sulphate (SDS).

Fig 2. Gluten content of wheat as influenced by various nutrient management approaches



The higher sedimentation value of wheat flour might be due to higher expansion and sedimentation of gluten that led to high-quality and high-strength gluten (Pena, 2002). Therefore, sedimentation value can be used as an essential indicator for detecting the quality of gluten.

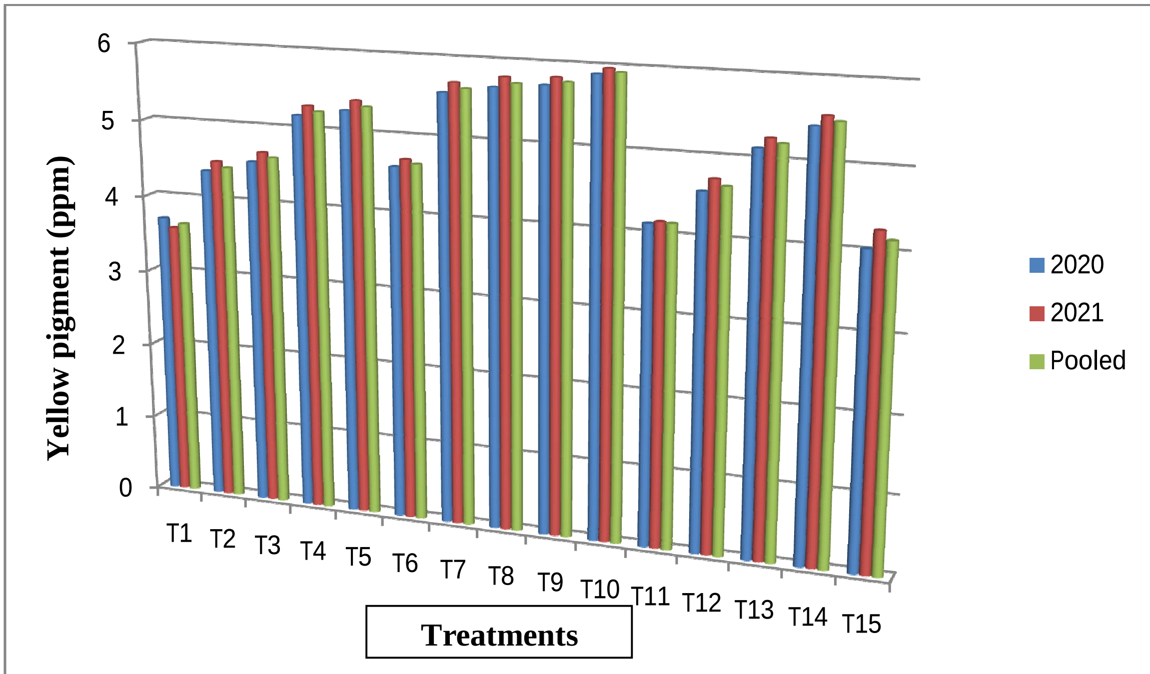
Fig 3. Sedimentation value of wheat as influenced by various nutrient management approaches



3.4 Yellow pigment:

Yellow pigment content is another quality parameter that imparts attractive yellow colour to the wheat products. It is precursor of vitamin 'A' and hence has immense nutritional importance. Higher yellow pigment in wheat grain was recorded in the treatment with target yield at 55 q ha^{-1} (5.93 ppm) under SSNM practice (T_{10}) and was on par with yield targets at 50 (T_9)(5.78 ppm) and 45 q ha^{-1} (T_8)(5.73 ppm) under the same nutrient management practice but differed significantly with other treatments (Table 3 and Fig. 4). Yellow pigment in wheat grain during individual years ranged from 3.70 (T_1) to 5.90 ppm (T_{10}) in 2021-22 and 3.58 (T_1) to 5.97 ppm (T_{10}) in 2021-22 and the results were similar to pooled analysis. This is attributed to improvement in grain quality traits such as protein and gluten contents in grain which significantly influenced the yellow pigment.

Fig 4. Sedimentation value of wheat as influenced by various nutrient management approaches



4. CONCLUSION

Site specific nutrient management approach for yield targeted at 55 q ha^{-1} significantly improved protein content, gluten content, sedimentation value and yellow pigment in bread wheat over other approaches viz., soil test laboratory (STL), soil test crop response (STCR) and nutrient expert (NE).

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Table 3: Effect of different fertilizer recommendation approaches on wheat quality

Treatments	Protein content (%)			Sedimentation value (ml)			Yellow pigment (ppm)		
	2020	2021	Pooled	2020	2021	Pooled	2020	2021	Pooled
T_1: Absolute control	9.84	9.60	**9.72**	28.3	27.9	**28.1**	3.70	3.58	**3.64**
T_2: RDF	11.88	11.21	**11.54**	36.4	36.7	**36.6**	4.37	4.50	**4.43**
T_3: RPP	11.97	12.26	**12.11**	37.5	37.9	**37.7**	4.53	4.66	**4.60**
T_4: 125% RDF	12.10	12.16	**12.13**	39.1	39.5	**39.3**	5.17	5.30	**5.23**
T_5: 150% RDF	12.41	12.83	**12.61**	39.2	39.5	**39.4**	5.27	5.40	**5.33**
T_6: STL approach	11.97	12.43	**12.20**	38.6	39.3	**38.9**	4.60	4.70	**4.65**
T_7: SSNM yield target at 40 q ha^{-1}	12.54	12.84	**12.69**	41.3	41.7	**41.5**	5.57	5.70	**5.63**
T_8: SSNM yield target at 45 q ha^{-1}	12.83	13.22	**13.02**	42.6	43.0	**42.8**	5.67	5.80	**5.73**
T_9: SSNM yield target at 50 q ha^{-1}	13.01	13.57	**13.29**	44.5	44.8	**44.7**	5.73	5.83	**5.78**
T_{10}: SSNM yield target at 55 q ha^{-1}	13.17	13.70	**13.43**	46.1	46.5	**46.3**	5.90	5.97	**5.93**
T_{11}: STCR yield target at 40 q ha^{-1}	11.97	12.43	**12.21**	35.4	36.2	**35.8**	4.13	4.16	**4.15**
T_{12}: STCR yield target at 45 q ha^{-1}	11.38	11.54	**11.46**	35.8	38.2	**37.0**	4.57	4.73	**4.65**
T_{13}: STCR yield target at 50 q ha^{-1}	12.12	12.84	**12.48**	39.1	39.0	**39.0**	5.13	5.26	**5.20**
T_{14}: STCR yield target at 55 q ha^{-1}	12.56	13.11	**12.83**	40.1	40.4	**40.2**	5.43	5.56	**5.50**
T_{15}: NE yield target at 40 q ha^{-1}	11.78	12.08	**11.93**	35.4	35.7	**35.5**	4.03	4.26	**4.15**
SEm±	0.23	0.24	**0.16**	0.84	0.88	**0.73**	0.10	0.08	**0.08**
CD(0.05)	0.65	0.69	**0.45**	2.43	2.54	**2.12**	0.29	0.22	**0.23**
CV (%)	3.2	3.4	**2.2**	3.8	3.9	**3.3**	3.5	2.7	**2.8**

Table 4: Effect of different fertilizer recommendation approaches on wheat quality

Treatments	Wet gluten (%)			Dry gluten (%)			Gluten index (%)		
	2020	2021	Pooled	2020	2021	Pooled	2020	2021	Pooled
T_1: Absolute control	25.4	24.8	**25.1**	7.7	7.5	**7.6**	69.9	69.3	**69.6**
T_2: RDF	30.6	28.9	**29.8**	9.7	9.0	**9.4**	73.1	73.3	**73.2**
T_3: RPP	30.9	31.6	**31.3**	9.8	10.1	**9.9**	73.3	73.5	**73.4**
T_4: 125% RDF	31.2	31.4	**31.3**	9.9	10.0	**10.0**	73.5	73.9	**73.7**
T_5: 150% RDF	32.0	33.1	**32.5**	10.8	11.2	**11.0**	75.6	76.0	**75.8**
T_6: STL approach	30.9	32.1	**31.5**	9.8	10.2	**10.0**	74.3	74.7	**74.5**
T_7: SSNM yield target at 40 q ha^{-1}	32.4	33.1	**32.7**	10.9	11.2	**11.1**	75.9	76.8	**76.4**
T_8: SSNM yield target at 45 q ha^{-1}	33.1	34.1	**33.6**	11.2	11.6	**11.5**	77.5	78.4	**78.0**
T_9: SSNM yield target at 50 q ha^{-1}	33.6	35.0	**34.3**	11.4	11.9	**11.7**	78.1	79.0	**78.6**
T_{10}: SSNM yield target at 55 q ha^{-1}	34.0	35.3	**34.7**	11.5	12.3	**11.9**	81.2	82.1	**81.6**
T_{11}: STCR yield target at 40 q ha^{-1}	29.4	32.1	**30.7**	9.8	10.2	**10.0**	72.7	73.2	**73.0**
T_{12}: STCR yield target at 45 q ha^{-1}	30.9	29.8	**30.4**	9.2	9.4	**9.3**	74.7	75.2	**75.0**
T_{13}: STCR yield target at 50 q ha^{-1}	31.3	33.1	**32.2**	9.9	10.7	**10.3**	75.6	76.1	**75.9**
T_{14}: STCR yield target at 55 q ha^{-1}	32.4	33.7	**33.1**	10.9	11.5	**11.2**	76.5	77.0	**76.7**
T_{15}: NE yield target at 40 q ha^{-1}	30.4	31.2	**30.8**	9.6	9.9	**9.8**	70.7	70.9	**70.8**
SEm±	0.5	0.5	**0.4**	0.2	0.2	**0.1**	1.4	1.4	**1.4**
CD(0.05)	1.4	1.5	**1.2**	0.5	0.7	**0.4**	4.0	4.0	**4.0**
CV (%)	3.3	3.4	**2.2**	3.0	4.0	**2.6**	3.3	3.2	**3.2**