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YIELD AND QUALITY OF BREAD WHEAT (*TRITICUM AESTIVUM* L. EMEND. FIORI AND PAOL.) INFLUENCED BY NITROGEN LEVELS AND ITS SPLIT APPLICATION

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ABSTRACT
A field experiment was conducted at the Agronomy Instructional Farm, SDAU, Sardarkrushinagar (Gujarat) during the *rabi* season of the years 2013-14 and 2014-15 to evaluate effect of nitrogen levels and its split application on yield and quality of wheat. The experiment consisted of fourteen treatment combinations comprised of two nitrogen levels and seven split applications and conducted in RBD with factorial concept with three replications. Grain yield 4572 kg/ha and quality parameters *i.e.* protein content (12.63 %), wet gluten (29.73 %) and sedimentation value (40.93 ml) and available nitrogen in soil after harvest were found significantly superior under the application of 160 kg N/ha. Grain yield (4964 kg/ha) and straw yield (5792 kg/ha) were significantly higher when nitrogen applied as 50% at sowing, 25% at CRI and 25% at 1st node stage. Quality parameters *i.e.* protein content (12.21 percent), wet gluten content (29.87 percent), hectoliter weight (81.57 kg/ml), sedimentation value (41.23 ml) and grain diameter (2.82 mm) were significantly higher under splitting of nitrogen as 10% each at sowing, CRI, 1st node, tillering, flag leaf, heading, flowering, milking, dough and hard dough stage (S_7).

INTRODUCTION

Wheat is one of the most important staple food crops of India grown in diverse agro-climatic conditions from 11 ºN- 35ºN latitude and 72ºE- 92ºE longitudes. Wheat *(Triticum* spp.) a feeding bowl to mankind occupies a premier position of all the staple food grain crops and an intellectual challenge that posses in a range of biological disciplines, archaeology, social and economic history. The major three main species of wheat *viz., Triticum aestivum, Triticum durum* and *Triticum dicocum* L. are cultivated in India, however, *Triticum aestivum and Triticum durum* are popularly grown in Gujarat.

Wheat crop provide 11-12 % Protein to human and by product wheat-straw also a good source of nutrition in animals. Taking in to the consideration the consumption pattern of calories, it is estimated that population will require food grain to the tune of 219.5 MT adding an indirect demand of feed, seed, industrial uses *etc*., additional 26.2 m t of food grain will be required, thus projection of an overall food grain demand of 245.7 MT in year 2010. Out of this 85.5 MT has been estimated to come from wheat alone. That is way we have to increase wheat productivity further to satisfy the need of ever growing population (DWR, 2013).

Among the nutrients, nitrogen plays an important role in wheat production. Low level of nitrogen results in lower yield and higher level of nitrogen causes environmental pollution and also increases cost of cultivation. Indian soils are deficient in nitrogen. Deficiency of this major element is a limiting factor in crop production in this country. It is, therefore, required to be added in appropriate quantity to the soil at a time when it could be best utilized by the crop plant for their optimum responses for increasing yield of wheat Mattas *et al*. (2011).

The wheat plant absorbs 75 to 80 percent up to first and second node stage nitrogen, but very little absorption of nitrogen continues till maturity. As per the biology of wheat crop little falls in nitrogen content in cell, disturbing the biochemical process in plant resulting in to low tillering, grain size and ultimately yield (Mengel and Kirkby, 1987).

The fact that high yielding varieties of wheat possess high yield potential is undoubtedly associated with their tendency to consume high dose of nitrogen. But the utilization efficiency of added nitrogen fertilizer is about 50 to 70 percent, as applied nitrogen is subjected to various kinds of losses. In order to get maximum benefit from nitrogen nutrient, it should not only be applied in right quantity but also at right time. Application of nitrogen not synchronizing with the demand of the plant may result in various losses (Verma and Srivastava, 1989).

Patel *et al*. (2004) reported that higher quantity of nitrogen applied in more number of split, it increased the yield and quality parameters in wheat. Similar founding was done by Negi *et al*.(2013) and Mattas *et al*. (2011).

As per the literature and SDAU recommendations nitrogen should be split in two install after sowing. The research studies in nitrogen management indicate positive response to more than two split in light textured soil. The response varies

temperature window of the crop and therefore there is a tendency in farmer's community to split nitrogen up to hard dough stage because they believe improvement in quality and luster of the grain. No scientific data base information is available for North Gujarat wheat growing area in relation to multi splitting of nitrogen and their effect on yield and quality of wheat. In the context of above observation, present investigation was carried out to study the "Effect of levels of nitrogen and its split application on wheat (*Triticum aestivum* L. emend. Fiori and paol.) under North Gujarat Condition".

The paper deals with the effect of nitrogen levels and its split application on yield and quality of wheat.

MATERIALS AND METHODS

The field experiment was laid out in Plot C-9 at the Agronomy Instructional Farm, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar during the *rabi* season of the years 2013-14 and 2014-15. Geographically, Sardarkrushinagar is situated at 24º-19' North latitude and 72º-19' East longitude with an elevation of 154.52 m above the mean sea level. This centre is located in the North Gujarat Agro-climatic Zone (AES-IV) of Gujarat. The experimental field has an even topography with a gentle slope having good drainage. The soil samples were taken randomly from experimental plot to a depth of 0-15 and 15-30 cm. The soil was loamy sand in texture, low in organic carbon and available nitrogen, medium in available phosphorus and high in available potash. The experiment was conducted in Randomized Block Design with factorial concept with 3 replications. Wheat variety GW 322 was sown in the experiment. The treatments consisted of 2 levels of nitrogen (120 kg/ha and 160 kg/ha) and and 7 split application of nitrogen, *viz*, S_1: 50% at sowing and 50% at CRI stage, S_2: 50% at sowing, 25% at CRI stage and 25% at 1st node stage, S_3: 25% at sowing, 25% at 1st node stage, 25% at tillering stage and 25% at heading stage, S_4 : 25% at CRI, 25% at 1st node stage, 25% at flag leaf stage and 25% at milking stage, S_5 : 20% at sowing, 20% at CRI, 20% at 1st node stage, 20% at flag leaf stage and 20% at flowering stage, S_6 : 20% at sowing, 20% at 1st node stage, 20% at flag leaf stage, 20% milking stage and 20% at dough stage and S_7 : 10% each at sowing, CRI, 1st node stage, tillering stage, flag leaf stage, heading stage, flowering stage, milking stage, dough stage and hard dough stage. Nitrogen application from Urea as per the treatments and Common application of Phosphorus and Potash at 60 kg P_2O_5/ha and 30 kg/ha K_2O as a basal dose for all the treatments respectively. The sowing of wheat was done on 22th November during the first year and 25th November during second year with hand sowing in dry moist soil. Seeds were treated with Fipronil 5% at 6 g/kg seed for termite and white grub control. Pendimethalin @ 1 kg a.i. /ha was sprayed as pre emergence for weed control after 24 hours of sowing. The left over weed was control by spraying Metsulfuron methyl 4 g/ha. Irrigation was applied as per requirement. Wheat was harvested during 3rd April during first year and 20th March during second year. Observations of quality were recorded after threshing of wheat. Protein content of grain was computed by multiplying the value of nitrogen content with conversion factor 6.25 (Jones D.B. 1931). Moisture percent, Starch (DM) percent, Sedimentation Value (ml) analyzed by INFRATEC™ 1241 GRAIN ANALYZER (FOSS, Slanger upgade 69 DK-3400 Hilleroed, Denmark) from wheat grain. Hectoliter weight (kg/ml) analyzed by Hectoliter Weight Kit (Greenway *et al.,* 1971). Wet Gluten content, Hardness (HI) and Diameter (mm) analyzed by Single Kernel Characterization System (SKCS 4100) (Perten Instruments) controlled by the MicroSoft Windows software SK4100, v. 2,1,0,1. from wheat grain.

RESULTS AND DISCUSSION

Nitrogen levels

Higher dose of nitrogen *i.e.* 160 kg/ha (N_2) brought significant increase in grain yield during both the years and pooled analysis. On pooled data basis the treatments N_1 and N_2 recorded 4260 and 4573 kg/ha grain yield, respectively. The magnitude of increase in yield under application of 160 kg N/ha was to the tune of 7.35 percent over application of 120 kg N/ha.

The remarkable increase in yields with higher levels of nitrogen might be attributed to favourable effect on yield attributes *viz*., plant height, dry matter accumulation, number of leaves per plant, total and effective tillers per meter row length. The increase in yield due to nitrogen application might have ultimately resulted in higher photosynthetic activities and in production of more photosynthates. This readily supplied food to growing parts of plant might have helped in improvement of growth and yield attributes like plant height, number of tillers per meter row. As a results of cumulate performance of all these attributes, application of 160 kg N/ha exhibited better response grain yield in the present study (Patel *et al*. (2004), Kachroo and Rajdan (2006), Singh *et al*. (2007), Gupta *et al*.(2011), Mattas *et al*. (2011), Seema *et al*. (2014) and Shah *et al*. (2015)). On the other hand, straw yield and harvest index found to be non-significant.

Quality parameter of grain studied during the course of investigation only the protein content (12.63 %), wet gluten (29.73 %) and sedimentation value (40.93 ml) were found significantly superior under the application of 160 kg N/ha over 120 kg N/ha. Rest of the parameters was found to be non-significant. On the basis of pooled data, maximum protein content in gain (12.63 percent) was observed with application of 160 kg N/ha followed by 120 (11.38 per cent). The increase in protein content of wheat grain was to the extent of 10.98 per cent due to application of 160 kg N/ha over 120 kg N/ha (N_1). This increase in protein content of wheat could be attributed to increase in nitrogen content in plant along with increase in nitrogen application might have helped in synthesis of more protein as nitrogen being a constituent of various metabolites including protein and amino acids. Patel *et al.* (2004) have also reported increase in protein content with increase in level of nitrogen in wheat grain. Application of 160 kg N/ha significantly increase the wet gluten content than 120 kg N/ha. 160 kg/ha N gave significantly the highest sedimentation value (40.93 ml). The result supported by Patel *et al.* (2004).

Split application of nitrogen

Split application as 50% at sowing, 25% at CRI stage and 25%

Table 1: Yield and Harvest index as influenced by nitrogen levels and its split application

Treatments	Yield (kg/ha)						Harvest index (%)		
	Grain yield			Straw yield					
	2013-14	2014-15	Pooled	2013-14	2014-15	Pooled	2013-14	2014-15	Pooled
Levels of nitrogen (N)									
N_1 : 120 kg/ha	4322	4197	4259	5103	5165	5134	46.2	45.1	45.6
N_2 : 160 kg/ha	4635	4510	4572	5257	5293	5275	47	46.1	46.6
SEM±	83	82	58	161	145	108	1.1	0.9	0.7
CD at 5 %	241	238	165	NS	NS	NS	NS	NS	NS
Split application of nitrogen (S)									
S_1 : 50% at sowing and 50% at CRI stage	4633	4508	4570	5745	5732	5739	44.8	44	44.4
S_2 : 50% at sowing, 25% at CRI stage and 25% at 1st node stage	5026	4901	4964	5790	5795	5792	46.6	45.8	46.2
S_3 : 25% at sowing, 25% at 1st no de stage, 25% at tillering stage and 25% at heading stage	4556	4431	4494	5667	5630	5649	44.6	44.2	44.4
S_4 : 25% at CRI, 25% at 1st node stage, 25% at flag leaf stage and 25% at milking stage	3968	3843	3905	4418	4503	4461	47.4	46.1	46.8
S_5 : 20% at sowing, 20% at CRI, 20% at 1st node stage, 20% at flag leaf stage and 20% at flowering stage	4906	4781	4844	5718	5824	5771	46.1	45.1	45.6
S_6 : 20% at sowing, 20% at 1st node stage, 20% at flag leaf stage, 20% milking stage and 20% at dough stage	4312	4187	4249	4693	4801	4747	48.1	46.8	47.4
S_7 : 10% each at sowing, CRI, 1st node stage, tillering stage, flag leaf stage, heading stage, flowering stage, milking stage, dough stage and hard dough stage	3947	3822	3884	4230	4319	4274	48.5	47	47.7
SEM±	155	153	109	301	271	202	2.1	1.8	1.4
CD at 5 %	451	446	309	875	787	574	NS	NS	NS
Interaction									
N x S	NS	NS	NS	NS	NS	NS	NS	NS	NS
CV %	8.48	8.64	8.56	14.23	12.68	13.47	11	9.5	10.3

Table 2: Protein content, wet gluten content, hectoliter weight and sedimentation value of wheat grain as influenced by nitrogen levels and its split application

Treatments	Protein content (%)			Wet gluten content %			Hectoliter weight (kg/ml)			Sedimentation Value (ml)		
	2013-14	2014-15	Pooled	2013-14	2014-15	Pooled	2013-14	2014-15	Pooled	2013-14	2014-15	Pooled
Levels of nitrogen (N)												
N_1 : 120 kg/ha	11.43	11.32	11.38	28.77	28.90	28.83	80.61	80.54	80.57	40.05	39.78	39.92
N_2 : 160 kg/ha	12.67	12.60	12.63	29.85	29.73	29.79	80.55	80.50	80.53	41.08	40.79	40.93
SEM±	0.041	0.045	0.03 0.09	0.12	0.07	0.140	0.147	0.102	0.190	0.186	0.133	
CD at 5 %	0.12	0.13	0.09 0.26	0.34	0.21	NS	NS	NS	0.55	0.54	0.38	
Split application of nitrogen (S)												
S_1 : 50% at sowing and 50% at CRI stage	11.71	11.61	11.66	28.75	28.58	28.67	79.10	79.04	79.07	39.87	39.57	39.72
S_2 : 50% at sowing, 25% at CRI stage and 25% at 1st node stage	12.05	11.94	11.99	28.92	28.77	28.84	79.69	79.68	79.69	40.20	39.94	40.07
S_3 : 25% at sowing, 25% at 1st node stage, 25% at tillering stage and 25% at heading stage	11.98	11.85	11.92	28.90	29.00	28.95	80.21	80.18	80.19	40.42	40.15	40.28
S_4 : 25% at CRI, 25% at 1st node stage, 25% at flag leaf stage and 25% at milking stage	12.04	11.95	11.99	29.63	29.73	29.68	80.76	80.69	80.72	40.62	40.36	40.49
S_5 : 20% at sowing, 20% at CRI, 20% at 1st node stage, 20% at flag leaf stage and 20% at flowering stage	12.16	12.13	12.14	29.80	29.85	29.83	81.55	81.50	81.53	41.27	40.98	41.13
S_6 : 20% at sowing, 20% at 1st node stage, 20% at flag leaf stage, 20% milking stage and 20% at dough stage	12.17	12.06	12.11	29.35	29.35	29.35	81.13	81.05	81.09	40.22	39.93	40.08
S_7 : 10% each at sowing, CRI, 1st node stage, tillering stage, flag leaf stage, heading stage, flowering stage, milking stage, dough stage and hard dough stage	12.25	12.17	12.21	29.82	29.92	29.87	81.62	81.53	81.57	41.37	41.08	41.23
SEM±	0.076	0.085	0.06	0.16	0.22	0.14	0.262	0.275	0.190	0.356	0.349	0.249
CD at 5 %	0.22	0.25	0.16	0.48	0.63	0.39	0.76	0.80	0.54	1.03	1.01	0.71
Interaction												
N x S	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
CV %	1.54	1.74	1.64	1.37	1.82	1.61	0.80	0.84	0.82	2.15	2.12	2.13

Table 3: Starch, moisture content, hardness index and grain diameter of wheat grain as influenced by nitrogen levels and its split application

Treatments	Starch (DM) (%)			Moisture %			Hardness index (%)			Grain diameter (mm)		
	2013-14	2014-15	Pooled	2013-14	2014-15	Pooled	2013-14	2014-15	Pooled	2013-14	2014-15	Pooled
Levels of nitrogen (N)												
N_1 : 120 kg/ha	64.06	63.80	63.93	10.81	10.77	10.79	83.09	82.97	83.03	2.82	2.69	2.75
N_2 : 160 kg/ha	64.07	63.81	63.94	10.80	10.79	10.79	82.89	82.80	82.84	2.83	2.69	2.76
SEM±	0.12	0.12	0.08	0.065	0.063	0.045	0.354	0.369	0.256	0.01	0.01	0.01
CD at 5 %	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Split application of nitrogen (S)												
S_1 : 50% at sowing and 50% at CRI stage	64.13	63.88	64.01	10.85	10.90	10.88	82.33	82.22	82.28	2.78	2.64	2.71
S_2 : 50% at sowing, 25% at CRI stage and 25% at 1st node stage	64.33	64.08	64.21	10.80	10.73	10.77	82.40	82.28	82.34	2.78	2.64	2.71
S_3 : 25% at sowing, 25% at 1st node stage, 25% at tillering stage and 25% at heading stage	64.07	63.82	63.94	10.83	10.77	10.80	82.72	82.62	82.67	2.80	2.66	2.73
S_4 : 25% at CRI, 25% at 1st node stage, 25% at flag leaf stage and 25% at milking stage	63.92	63.63	63.78	10.78	10.70	10.74	83.18	83.05	83.12	2.83	2.69	2.76
S_5 : 20% at sowing, 20% at CRI, 20% at 1st node stage, 20% at flag leaf stage and 20% at flowering stage	63.95	63.70	63.83	10.77	10.79	10.78	83.50	83.43	83.47	2.87	2.73	2.80
S_6 : 20% at sowing, 20% at 1st node stage, 20% at flag leaf stage, 20% milking stage and 20% at dough stage	64.03	63.77	63.90	10.78	10.78	10.78	83.02	82.90	82.96	2.84	2.70	2.77
S_7 : 10% each at sowing, CRI, 1st node stage, tillering stage, flag leaf stage, heading stage, flowering stage, milking stage, dough stage and hard dough stage	64.00	63.77	63.88	10.80	10.77	10.78	83.75	83.68	83.72	2.88	2.75	2.82
SEM±	0.22	0.22	0.15	0.122	0.117	0.085	0.662	0.690	0.478	0.02	0.02	0.01
CD at 5 %	NS	NS	NS	NS	NS	NS	NS	NS	NS	0.06	0.06	0.04
Interaction												
N x S	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
CV %	0.83	0.83	0.83	2.76	2.67	2.71	1.95	2.04	2.00	1.67	1.91	1.79

at 1st node stage recorded 4964 and 5793 kg/ha grain and straw yield, respectively on pooled basis. Based on pooled data under S_2, the percentage was increase to the tune of 27.77, 27.09, 16.8, 10.46, 8.60 and 2.48 percent over S_7, S_4, S_6, S_3, S_1 and S_5, respectively. Similar trends were observed in case of straw yield. Harvest index found to be non-significant. It might be attributed to favourable effect on yield attributes *viz*., plant height, dry matter accumulation, number of leaves per plant, total tillers and effective tillers per meter row length, ear length and no. of grains per ear. The average increase in yield might be owing to continuous and sufficient availability of nitrogen during the formation of spikelets in miniature plant around the first node stage. The increase in grain and biological yield may be due to the availability of nitrogen at various critical growth stages in optional amount that might have increased the yield attributes of wheat thus resulting in the increased grain and biological yield. Because of which, nitrogen yielded better response grain yield in the present study. Earlier workers have also reported such response of nitrogen to wheat *viz*. Patel *et al.*(2004), Kachroo and Rajdan (2006), Singh *et al*. (2007), Kaur *et al*. (2010), , Gupta *et al*. (2011), Mattas *et al*. (2011) and Meena *et al*. (2013) to wheat and Arun *et al* (2014) and Shantappa *et al*. (2014) to rice.

Effect of split application of nitrogen on quality of wheat grain indicated that protein content (12.21) being at par with splitting treatment S_5 (12.14) and S_6 (12.11) was recorded under splitting treatment S_7 (10% each at sowing, CRI, 1st node stage, tillering stage, flag leaf stage, heading stage, flowering stage, milking stage, dough stage and hard dough stage). Same way wet gluten content (29.87 %) being at par with S_5 (29.83) and S_4 (29.68), hectoliter weight (81.57) being at par with S_5 (81.53) and S_6 (81.09), sedimentation value (41.23) being at par with treatment S_5 (41.13) and grain diameter (2.82) being at par with S_5 (2.80) was recorded under the split application of nitrogen as 10% each at sowing, CRI, 1st node stage, tillering stage, flag leaf stage, heading stage, flowering stage, milking stage, dough stage and hard dough stage (S_7). While rest of the quality parameters like starch percent, moisture percent and hardness index were found to be non-significant. All the quality parameters are closely associated with amino acid concentration and bounding with each other and formation of amino acid. It is depend on nitrogen availability to crop at each growth stage, although the treatment S_7 not reflect in grain yield but application of nitrogen up to last stage has keep the biochemical processes in grain up to last stage resulted in higher values for quality straits. Patel *et al*. (2004) and Kaur *et al*. (2010) also reported similar positive changes with multiple splitting of nitrogen.

It was concluded that for getting higher yield 160 kg N/ha applied as 50% at basal ,25% at CRI and @% % at 1st node stage where best quality wheat grain can be produced with 160 kg N/ha applied as full split *i.e.* 10% each at sowing, CRI, 1st node stage, tillering stage, flag leaf stage, heading stage, flowering stage, milking stage, dough stage and hard dough stage.

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The main portion of the paper should be divided into Abstract, Introduction, Materials and Methods, Results, Discussion (or result and discussion together), Acknowledgements (if any) References and legends.

Abstract should be limited to 200 words and convey the main points of the paper-outline, results and conclusion or the significance of the results.

Introduction should give the reasons for doing the work. Detailed review of the literature is not necessary. The introduction should preferably conclude with a final paragraph stating concisely and clearly the aims and objectives of your investigation.

Materials and Methods should include a brief technical description of the methodology adopted while a detailed description is required if the methods are new.

Results should contain observations on experiment done illustrated by tables and figures. Use well known statistical tests in preference to obscure ones.

Discussion must not recapitulate results but should relate the author's experiments to other work on the subject and give their conclusions.

All tables and figures must be cited sequentially in the text. Figures should be abbreviated to Fig., except in the beginning of a sentence when the word Figure should be written out in full.

The figures should be drawn on a good quality tracing/ white paper with black ink with the legends provided on a separate sheet. Photographs should be black and white on a glossy sheet with sufficient contrast.

References should be kept to a minimum and listed in alphabetical order. Personal communication and unpublished data should not be included in the reference list. Unpublished papers accepted for publication may be included in the list by designating the journal followed by "in press" in parentheses in the reference list. The list of reference at the end of the text should be in the following format.

1. **Witkamp, M. and Olson, J. S. 1963.** Breakdown of confined and non-confined Oak Litter.*Oikos*. **14**:138-147.
2. **Odum, E.P. 1971.** *Fundamentals of Ecology*. W. B. Sauder Co. Publ. Philadelphia.p.28.
3. **Macfadyen, A.1963.** The contribution of microfauna to total soil metabolism. In:*Soil organism*, J. Doeksen and J. Van Der Drift (Eds). North Holland Publ. Comp., pp 3-16.

References in the text should be quoted by the **author's name and year** in parenthesis and presented in year order. When there are more than two authors the reference should be quoted as: first author followed by *et al.*, throughout the text. Where more than one paper with the same senior author has appeared in on year the references should

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