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Effect of wheat quality parameters under different environment and methos of sowing and correlation coefficient analysis in Tawa command area of Madhya Pradesh

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Abstract
The field experiment was conducted consisted of four thermal environments (E_1:15th November, E_2:30th November, E_3:15th December, E_4:30 December) and three sowing methods (M_1: Broadcast, M_2: Line sowing and M_3: Bed planting) with three replications in Split Plot Design. Results revealed that grain yield maximum (5262 and 4941 kg ha^{-1}) were found significantly higher in 15th November sowing environment as compared to other sowing environments. Grain yield (5050 and 4761 kg ha^{-1}) were found significantly higher in bed planting method than other methods. Grain yield reported significant positive correlation with harvest index (r=0.979) followed by hectolitre weight (r=0.947), iron (r=0.931), zinc (r=0.924), straw yield (r=0.909) and test weight (r=0.896), indicating that increase in these traits would increase grain yield while, significant negative association was reported for grain hardness (r=-0.735) and gluten index (r=-0.649).

Keywords: Grain yield, bed planting methods, protein, gluten, hectolitre weight, sedimentation, grain hardness, iron, zinc, wheat

Introduction
Wheat (*Triticum aestivum* L.) is the world's largest cultivated crop, which belongs to the family Poaceae and genus *Triticum*. Because of the acreage, it occupies productivity and its high adoptability to different agro-climatic and soil conditions and it is known as “King of Cereals”. Wheat cultivation has also been the symbol of the green revolution, self-sufficiency in food and sustained production (Alam, 2013) [3]. As wheat is a thermo-sensitive long-day plant, accordingly, temperature is a significant determinant climate constant for the development and efficiency of wheat. Improving the quality of different wheat cultivars to satisfy the demands of people in many developing countries is one of the main objectives of various breeding programmes. Presently the main objectives of plant breeders are to improve the quality of wheat varieties to full fill the demands of people. The ability to supply wheat that meets local demands for specific inducing quality requirements will thus become more crucial, also with the surplus production of wheat, in India is exporting it to many countries and maintains the quality of its wheat for competing in the international market.

Materials and Methods
The field experiment was conducted consisted of four thermal environments (E_1:15th November, E_2:30th November, E_3:15th December, E_4:30 December) and three sowing methods (M_1: Broadcast, M_2: Line sowing and M_3: Bed planting) with three replications in Split Plot Design. The field experiments were carried out for two consecutive years during the *rabi* seasons of 2019-20 and 2020-21 at JNKVV, Zonal Agricultural Research Station, Powarkheda, Narmadapuram. Powarkheda is situated in the Central Zone of India has a tropical and sub-tropical climate. This Centre is situated on the banks of the holy river Narmada at 77^0.42' N Latitude, 22^0.40'E Longitude and 299 m above mean sea level Altitude. It possesses deep black soil vertisol having pH 7.

Quality parameters
Determination of protein content
The protein content in sample was determined by using conventional micro-Kjeldehl digestion and distillation procedure as given in AOAC (1984).
Nitrogen and protein percent was calculated by the following formula:

$$\text{Nitrogen} = \frac{14 \text{ x Normality of } H_2SO_4 \text{ x Vol. of } H_2SO_4 \text{ x } 10}{\text{weight of sample (mg) x } 100}$$

Protein percent in the sample was estimated by multiplying nitrogen percent of sample by factor 6.25.

Protein (%) = Nitrogen % x 6.25

Determination of Gluten
Gluten is obtained when a flour sample is washed with a sodium chloride solution, the starch and all other soluble components are removed and only the gluten part is left. Ten grams of flour is required to perform this analysis.
1. Exactly 25g flour is kneaded with about 15-ml water to get a dough ball. The dough ball is allowed to remain immersed in water for one hour to ensure proper hydration after which, the starch is washed out by kneading gently in a gentle stream of water over a fine sieve or silk till the washed liquid is clear.
2. The gluten, which is cohesive, is pressed as dry as possible, and weighed.
3. The wet gluten so obtained is dried at 100ºC for 24 hr. and weighed again to get the value for dry gluten.

Calculation

$$\text{Wet gluten (\%)} = \frac{A}{cc} \text{ X } 100$$

$$\text{Dry gluten (\%)} \quad \frac{B}{c} \text{ X } 100$$

Where,
A = wt. Of wet gluten B = wt. Of dry gluten and C =wt. of flour.

Determination of Hectolitre weight (kg/hl)
A tube of 100 ml capacity was filled by grains that fell from a defined height using an overhead storage hopper. The grains were levelled in the tube with the help of a metallic lid and then grains were weighed and was recorded as kg hl^{-1}. Hectolitre weight (or weight per unit volume) is the weight of 100 litres of wheat and is the simplest criteria of wheat quality. It gives us a rough index of flour yield.

Determination of Sedimentation value
Grind 100 g. of wheat in lab grinder. Sieve ground wheat using 100 mesh. Place 3.2 g of flour in 100-ml glass stoppered graduated cylinder. Add 50 ml water containing bromophenol blue. Mix thoroughly flour and water by moving the cylinder horizontally 12 times. Start the timer and place the cylinder on shaker for 5 min. remove the cylinder end add 25 ml isopropyl alcohol - lactic acid reagent. Place the cylinder again on shaker for 5 min. and let stand exactly 5 min. at the end of 5 min read the volume in ml of sediment in cylinder.
Calculate the value on 14% moisture basis. Sedimentation value is an index of quantity and quality of gluten.
Sedimentation value corrected to 14% moisture,
Uncorrected Sedimentation value

$$X = \frac{100 - 14}{100 - \text{original flour moisture}}$$

Determination of Hardness Measurement
Grain hardness is an important determinant of the end product quality in wheat. It is the main classification parameter for the global what trade. Grain hardness of kernel hardness (KH) affected parameters such as milling yield, starch damage and baking properties.

Determination of iron and zinc content in grain
One gram of plant material was taken in 100 ml conical flask, 10 ml mixture of di acid mixture (2.5:1 of AR grade HCL4:HNO3 respectively) was added to each flask and whole mass was digested on hot plate to get white solution. The digestate was transferred in 50 ml volumetric flask and volume was made up to the mark with distilled water and analysed on atomic absorption Spectro-photometer (Jackson, 1965) [16].

Results and Discussion
Correlation coefficients
Correlation coefficients analysis is the measurement of the degree and direction of relationships between various characters. It is a widely used measure association between traits (Schober *et al*., 2018) [12]. A Pearson correlation is a measure of a linear association between two normally distributed random variables. It is simple, intuitive and is a very popular tool for analysing data in many scientific disciplines like agriculture, biology, medical sciences, and earth sciences (Pandey *et al*. 2021) [10]. In present study the correlation measure relation between various quality characters with yield and decide the component on which can be improve quality in wheat using agronomic practices along with yield.
Correlation coefficients for various yield and quality attributing traits were estimated. The findings of present investigation are furnished in table 1 and discussed under here-
Grain yield reported significant positive correlation with harvest index (r=0.979) followed by hectolitre weight (r=0.947), iron (r=0.931), zinc (r=0.924), straw yield (r=0.909) and test weight (r=0.896), indicating that increase in these traits would increase grain yield while, significant negative association was reported for grain hardness (r=-0.735) and gluten index (r=-0.649). These results were in agreement with those of Mecha *et al*. (2017) [9] and Chitralekha *et al*. (2018) [4] reported a strong positive correlation of total biomass and harvest index on grain yield. Other researchers indicated a positive correlation between grain yield and other traits such as harvest index, days to maturity (Rathod *et al*. 2019; Dabi *et al*. 2016) [11, 6], and 1000 grain yield (Singh *et al*. 2012) [17].

Protein showed significant positive correlation with sedimentation (r=0.897) gluten index (r=0.808) and grain hardness (r=0.628) which indicated the same trend of variation of gluten index, grain hardness and protein concentration. While, significant negative association was reported for zinc (r=-0.628). The results were in agreement with the findings of Semnaninejad *et al*. (2021) [8].

Gluten index reported significant positive correlation with sedimentation (r=0.940), grain hardness (r=0.905) while, significant negative correlation was reported for zinc (r=-0.759) followed by hectolitre weight (r=-0.737), harvest index (r=-0.651) and iron (r=-0.596), these results were quite in agreement with the findings of Sourour *et al.* (2018) [18].

Hectolitre weight showed highly significant positive correlation with harvest index (r=0.973), zinc (r=0.972), iron (r=0.853), straw yield (r=0.794) and test weight (r=0.673), while its negative correlation was reported for grain hardness (r=-0.896) and sedimentation (r=-0.680). The results were in agreement with the findings of Sedimentation showed significant positive correlation with grain hardness (r=0.829), while, its showed significant negative correlation with zinc (r=0.675), Iron (r=-0.598). Barnard *et al.* (2002) [3], Yagdi & Sozen (2009) [13] and Chung *et al*. (2003) [5].

Grain hardness reported no significant positive correlation with any characters, while, negative correlation was reported with zinc (r=-0.884) and iron (r=-0.862).

Grain Fe and Zn concentrations are complex characters controlled by several components which reflect positive and negative effects on these traits. Thus, for achieving rational improvement in grain Fe and Zn concentrations and its components, knowledge of mechanism of association, cause and effect relationship provides a basis for formulating suitable selection methods for these components. Results indicate that 1000 grain weight, grain protein and test weight had positive (significant) correlation and sedimentation value had positive (non-significant) correlation at genotypic as well as phenotypic level with grain yield. Iron showed positive significant correlation with zinc (r=0.991), harvest index (r=0.945), straw yield (r=0.769) and test weight (r=0.762). The results were in agreement with the findings of Jhinjer *et al*. (2018) [19]. Zinc showed highly significant positive correlation with harvest index (r=0.957), straw yield (r=0.741) and test weight (r=0.740). The results were in agreement with the findings of Jhinjer *et al.* (2018) [19].

Test weight showed highly significant positive correlation with straw yield (r=0.854) and harvest index (r=0.846). Harvest index showed highly significant positive correlation with straw yield (r=0.814). There are reports about the correlation between thousand grain weight and grain yield per plant. Our results also agree with previous findings (Saleh, 2011; Dogan, 2009; Prajapat, 2020) [14, 7, 15]. These results show that most agronomical traits are inversely correlated with quality chrematistics.

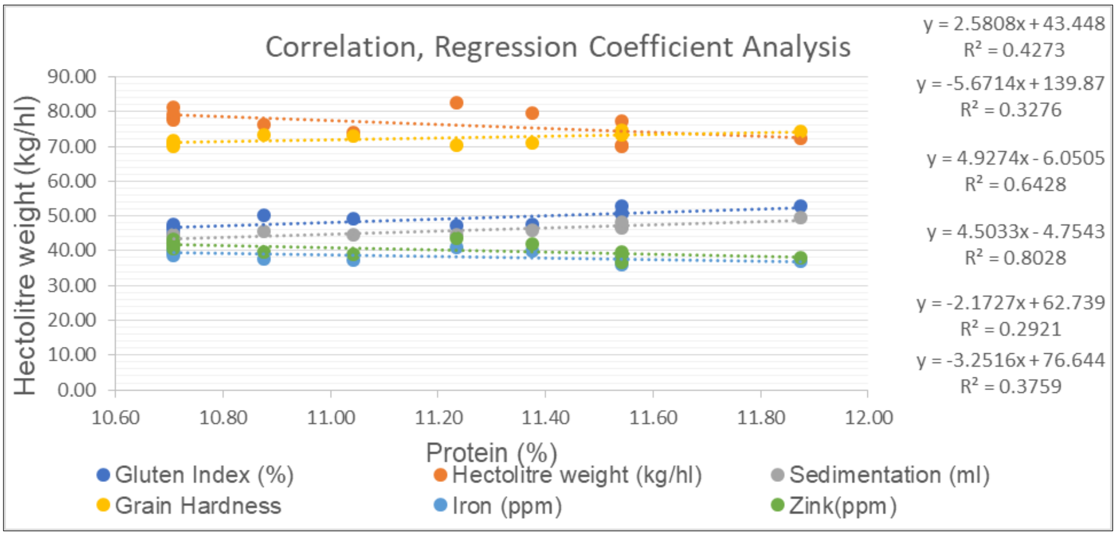

Fig 1: Correlation, Regression Coefficient Analysis, Protein (%), Gluten Index (%), Hectolitre weight (kg/hl), Sedimentation (ml), Grain Hardness, Iron and zinc (ppm)

Table 1: Correlation Coefficient Analysis among Yield and quality parameters of wheat as influenced by different environments and sowing methods

Treatments	Protein (%)	Gluten Index (%)	Hectolitre weight (kg/hl)	Sedimentation (ml)	Grain Hardness	Iron (ppm)	Zinc (ppm)	Test weight (g)	Harvest Index	Straw yield kg/ha	Grain yield kg/ha
Protein (%)	1.00										
Gluten Index (%)	0.802**	1.00									
Hectolitre weight (kg/hl)	-0.572^{NS}	-0.826**	1.00								
Sedimentation (ml)	0.897**	0.928**	-0.658*	1.00							
Grain Hardness	0.654*	0.956**	-0.858**	0.829**	1.00						
Iron (ppm)	-0.541^{NS}	-0.809**	0.947**	-0.598*	-0.862**	1.00					
Zinc (ppm)	-0.613*	-0.855**	0.971**	-0.675*	-0.884**	0.991**	1.00				
Test weight (g)	-0.107^{NS}	-0.335^{NS}	0.765**	-0.117^{NS}	-0.414^{NS}	0.762**	0.740**	1.00			
Harvest Index	-0.476^{NS}	-0.753**	0.977**	-0.559^{NS}	-0.813**	0.945**	0.957**	0.846**	1.00		
Straw yield kg/ha	-0.067^{NS}	-0.364^{NS}	0.776**	-0.073^{NS}	-0.471^{NS}	0.769**	0.741**	0.854**	0.814**	1.00	
Grain yield kg/ha	-0.332^{NS}	-0.649*	0.947**	-0.407^{NS}	-0.735**	0.931**	0.924**	0.896**	0.979**	0.909**	1.00

Conclusion
Grain yield reported significant positive correlation with harvest index hectolitre weight, iron, zinc, straw yield and test weight indicating that increase in these traits would increase grain yield. Correlation coefficients analysis is the measurement of the degree and direction of relationships between various characters. It is a widely used measure association between traits.

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