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Studies on Selection Indices for Wheat (*Triticum aestivum* L.) Improvement Using Interrelationship and Path Analysis under Sub-Tropical Conditions of Indore Region

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

In Rabi 2022–2023 at Central Research Farm, Oriental University Indore, Madhya Pradesh, twenty varieties of wheat (*Triticum aestivum* L.) were used in this investigation, which was conducted using an RBD design with three replications. Thirteen quantitative characters were used to record data in order to study the relationships and path analysis between the characters. Correlation studies showed that biomass yield (0.891**, 0.511**), number of grains per spike (0.844**, 0.538**), and thousand seed weight (0.544**, 0.359**) exhibited significant positive correlation with grain yield at both genotypic and phenotypic level. Based on mean performance, JW 3020 (343.687 g) displayed the highest grain yield per running meter. At both the genotypic and

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phenotypic levels, the characters such as days to maturity (-0.473**, -0.609**) showed a negative correlation with grain yield per running meter. Path analysis showed that characters such as days to maturity (-0.005, -0.0055) had negative direct effects on grain yield per running meter at both phenotypic and genotypic levels, and characters like number of grains per spike (0.835, 0.035), biomass yield (0.71, 0.765), and harvest index (0.089, 0.598) had direct positive effects on grain yield per running meter at both genotypic and phenotypic levels.

Keywords: Wheat; genotype; phenotype; characters; yield.

1. INTRODUCTION

"Wheat (*Triticum aestivum* L.), is one of the world's most significant cereal crops. It is a member of the Poaceae (Graminae) family. A crop with global importance, wheat is raised in a variety of habitats. It is a significant cereal crop grown in cool climates and contributes significantly to global food and nutritional security. 36% of the world's population receives food from it, and it accounts for 20% of all food calories" [1]. "Across the globe, wheat is the most widely grown cereal in terms of both area and productivity. Regarding Genetics: Compared to most other domesticated species, wheat has a more complex genetic makeup. While many wheat species are stable polyploids, with four sets of chromosomes (tetraploid) 2n=4x=28 or six sets of chromosomes (hexaploid) 2n=6x=42, some species are diploid (2n=2x=14), having two sets of chromosomes" [2].

"The wheat crop is ranked third in production but second in cultivation in the state of Madhya Pradesh, behind soybeans. Due to the state's climate and geography, Madhya Pradesh only has a small area dedicated to wheat cultivation. Madhya Pradesh produces 98.40 lakh tons of wheat annually from its 5.67 lakh hectares of wheat [3]. Compared to the national average of 27.13 quintals per hectare, the productivity is low at 20 quintals per hectare" [4]. "Grain yield is the result of numerous variables referred to as yield components and is a complex polygenic trait regulated by numerous genes interacting with the environment. It is frequently deceptive to choose parents solely on the basis of yield" [5]. "Correlation studies can provide information about the relative contributions of different traits to yield. A statistical tool for determining the strength and direction of a relationship between two or more variables is the correlation coefficient. The nature of the relationships between different plant characters is measured using correlation coefficient analysis, which also identifies the constituents of economically significant characters. Nevertheless, a simple correlation does not reveal enough about how each component contributes to yield. In order to determine the direct and indirect contribution of a trait to the yield, or final product, path coefficient analysis techniques are used" [6].

2. MATERIALS AND METHODS

The present investigation entitled "Selection indices for wheat (*Triticum aestivum* L.) improvement using interrelationship and path analysis sub-tropical conditions of Indore region" was conducted during the year 2021-2022 at Central Research Farm, Oriental University Indore Madhya Pradesh. The experimental material of the study comprised of 20 genetically diverse varieties of wheat (*Triticum aestivum* L.) was collected from College of Agriculture Indore Madhya Pradesh. The varieties used for experiment were MP 3336, MP 3269, JW 3288, JW 3173, JW 3211,Sujata, JW 3020, HD 2864, JW 1202, JW 1203, JW 1142, GW273, GW 322, JW 1201, JW 1106, HI 8498 , JW 1215, GW 366, MP 1106 and MP-1255 laid in RBD with three replications, each comprising of 3 rows of 2m length and row to row spacing was maintained at 23 cm. The observation on the characters viz., Days to 50% flowering, Days to maturity, Plant height, Number of tillers per running meter, Flag leaf length (cm), Flag leaf width (cm), Spike length (cm), Number of spikelet's per spike, Number of grains per spike, Biomass yield (g), Harvest index, thousand seed weight (g) and grain yield per running meter (g) were recorded on five randomly selected plants per replications.

The experimental data recorded were subjected to suitable statistical and biometrical analysis for the parameters, viz., range, mean, phenotypic correlation, genotypic correlation coefficient, phenotypic path coefficient analysis and genotypic path coefficient analysis [7].

3. RESULTS AND DISCUSSION

With the exception of flag leaf width, the mean sum of squares owing to the genotypes were significant for every character under investigation, indicating that there is a high

Table 1. Mean performance of wheat varieties for quantitative characters during Rabi 2022

Characters / Genotypes	Days to 50% flowering	Days to maturity	Plant height	Number of tillers per running meter	Flag leaf length	Flag leaf width	Spike length	Number of spikelets per spike	Number of grains per spike	Biomass yield	Harvest index	1000 seed weight	grain yield per running meter
MP 3336	184	252	100.533	100.667	17.42	0.983	9.333	38	34.867	400	45.1	51.1	179.017
MP 3269	177.333	251.333	99.4	88.533	17.04	0.933	10	49	41	400	45.9	50.367	182.467
JW 3288	178	245	103.4	94.767	20.753	0.86	8.453	44	30.533	316.667	48.303	52.967	152.283
JW 3173	178.667	243.667	95.667	102.333	23.153	1.207	9.513	53	48	450	62	57.033	279.957
JW 3211	184.667	252	103.6	75.2	23.48	1.02	9.62	53	49.867	500	45.733	60.233	228.953
Sujata	178	247.667	99.667	102.433	19.227	0.71	8.533	39	37.467	350	55.033	49.833	190.41
JW 3020	181	219.333	107.4	106.533	18.59	1.917	12.433	57	44.333	500	46.967	49.533	343.687
HD 2864	184.333	260.667	105.6	96	17.997	0.933	8.053	38	39.133	300	57.2	45.667	168.067
JW 1202	181	250.333	105	99.767	19.137	0.873	9.033	48	36.067	400	42.633	46.267	169.613
JW 1203	184.333	252.667	151	117.433	18.59	0.747	8.013	43	39.067	500	47.9	52.767	237.81
JW 1142	177.667	252	99.733	66.533	17.567	1.04	9.047	44	37.4	300	59.7	52.7	176.7
GW273	174.667	255	107.6	115.2	19.077	0.653	7.6	39	41.333	500	47.433	52.133	235.763
GW 322	181	253.333	102.6	65.867	16.967	0.827	9.347	55	37.933	400	53.873	60.967	215.65
JW 1201	179.333	258.667	112.167	94.533	21.233	0.913	9.56	50	43.467	400	56.867	50.733	226.767
JW 1106	178.667	261.667	106.467	87.767	16.223	0.627	8.467	42	36.2	300	47.6	37.333	141.09
HI 8498	185.333	258.333	99.667	61.767	15.173	0.777	10.633	47	46.667	400	58.373	54.533	234.75
JW 1215	182.667	254	107.333	97.533	16.34	0.89	10.133	45	43.6	500	54.027	56.5	267.267
GW 366	191.333	261.333	98.067	106.1	20.98	0.717	9.333	47	40.067	450	44.373	48.3	198.877
MP 1106 (C1)	185	254.333	96.2	113.667	18.1	0.887	7.4	36	38.667	433.333	43.57	49.5	188.657
MP-1255 (C2)	175.333	245.333	98.4	65.1	16.23	0.83	8.613	47	38.6	350	57.917	57.633	203.093
Mean	181.1167	251.4333	104.9751	92.88665	18.66385	0.9172	9.15585	45.7	40.2134	407.5	51.0251	51.80495	211.0439
CD	21.331	21.981	29.189	60.568	142.332	29.204	39.337	23.871	40.433	25.355	22.811	24.742	399.278
SED	10.629	10.953	44.544	30.18	70.922	14.552	19.601	11.895	20.147	12.634	11.367	12.328	198.954

Table 2. Genotypic Correlation coefficient between grain yield per running meter and its attributes in 20 wheat varieties Rabi 2022

Characters / Characters	Days to 50% flowering	Days to maturity	Plant height	Number of tillers per running meter	Flag leaf length	Flag leaf width	Spike length	Number of spikelets per spike	Number of grains per spike	Biomass yield	Harvest index	1000 seed weight	Grain yield per running meter
Days to 50% flowering													
Days to maturity	0.242*												
plant height(CM)	0.408**	-0.155NS											
No. of tillers per running meter	0.016NS	0.100NS	0.431**										
Flag leaf length(cm)	0.122NS	-0.016NS	0.030NS	0.107NS									
Flag leaf width(cm)	0.099NS	-0.312**	-0.252*	-0.093NS	0.545**								
Spike length	0.212*	-0.445**	-1.320**	-1.159**	0.279**	0.604**							
No. of spike lets per spike	0.095NS	-0.311**	-0.638**	-0.559**	0.334**	0.197NS	1.015**						
No. of grains per spike	0.239*	-0.254*	-0.293**	-0.231*	0.335**	0.346**	1.222**	0.583**					
Biomass yield(g)	0.082NS	-0.465**	1.242**	0.408**	0.345**	0.086NS	0.128NS	0.302**	0.533**				
Harvest index	-0.190NS	-0.067NS	-0.662**	-0.483**	-0.160NS	0.321**	0.691**	0.008NS	0.273**	-0.443**			
1000 seed weight(g)	-0.178NS	-0.465**	-0.004NS	-0.386**	0.249*	0.377**	0.538**	0.574**	0.450**	0.267*	0.532**		
Grain yield per running meter	-0.049NS	-0.473**	0.698**	0.117NS	0.165NS	0.359**	0.810**	0.311**	0.844**	0.891**	0.129NS	0.544**	

Table 3. Phenotypic Correlation coefficient between grain yield per running meter and its attributes in 20 wheat varieties Rabi 2022

Characters / Characters	Days to 50% flowering	Days to maturity	Plant height	Number of tillers per running meter	Flag leaf length	Flag leaf width	Spike length	Number of spikelets per spike	Number of grains per spike	Biomass yield	Harvest index	1000 seed weight	Grain yield per running meter
Days to 50% flowering													
Days to maturity	0.170^{NS}												
plant height(CM)	0.005^{NS}	0.043^{NS}											
No. of tillers per running meter	-0.017^{NS}	-0.004^{NS}	0.135^{NS}										
Flag leaf length(cm)	0.148^{NS}	-0.132^{NS}	-0.030^{NS}	0.092^{NS}									
Flag leaf width(cm)	0.131^{NS}	-0.133^{NS}	-0.124^{NS}	-0.082^{NS}	0.418**								
Spike length	0.102^{NS}	0.002^{NS}	0.006^{NS}	-0.367**	-0.007^{NS}	0.150^{NS}							
No. of spike lets per spike	0.026^{NS}	-0.173^{NS}	-0.015^{NS}	-0.380**	0.221*	0.185^{NS}	0.198^{NS}						
No. of grains per spike	0.124^{NS}	-0.058^{NS}	-0.095^{NS}	-0.181^{NS}	0.329**	0.215*	0.166^{NS}	0.252*					
Biomass yield(g)	0.088^{NS}	-0.024^{NS}	0.045^{NS}	0.233*	0.181^{NS}	-0.006^{NS}	-0.005^{NS}	0.131^{NS}	0.400**				
Harvest index	-0.086^{NS}	-0.037^{NS}	0.049^{NS}	-0.216*	-0.016^{NS}	0.100^{NS}	0.142^{NS}	-0.033^{NS}	0.312**	-0.418**			
1000 seed weight(g)	-0.072^{NS}	-0.085^{NS}	-0.095^{NS}	-0.350**	0.145^{NS}	0.175^{NS}	0.149^{NS}	0.307**	0.335**	0.459**	0.110^{NS}		
Grain yield per running meter	0.038^{NS}	-0.609**	0.065^{NS}	0.087^{NS}	0.209*	0.116^{NS}	0.082^{NS}	0.181^{NS}	0.538**	0.511**	0.284**	0.359**	

Table 4. Direct and indirect effects between grain yield per running meter and its components in 20 wheat varieties at genotypic level Rabi 2022

Character / Character	Days to 50% flowering	Days to maturity	plant height(CM)	No. of tillers /meter	Flag leaf length(cm)	Flag leaf width(cm)	Spike length	No. of spike lets	No. of grains/ spike	Biomass yield(gm)	Harvest index	1000 seed weight(gm)
Days to 50% flowering	**-0.23831**	-0.00474	-0.00272	-0.001	-0.03153	0.04156	-0.01699	0.02442	0.16595	0.05801	-0.01693	-0.01859
Days to maturity	-0.21535	**-0.00525**	-0.03912	-0.0947	0.08485	0.94826	-0.03293	0.85665	-1.81065	0.33127	-0.0949	-0.09003
plant height(CM)	-0.09733	-0.03085	**-0.00666**	-0.02697	-0.00787	-0.10574	0.10583	0.14345	-0.1112	0.88114	-0.05894	-0.00042
No. of tillers per running meter	-0.00382	-0.00795	-0.00287	**-0.06254**	-0.0278	-0.03888	0.09289	0.16567	-0.2072	0.28963	-0.04301	-0.0403
Flag leaf length(cm)	-0.02898	0.00172	-0.0002	-0.00671	**-0.25923**	0.2287	-0.02233	-0.105	0.17111	0.24494	-0.01427	0.02601
Flag leaf width(cm)	-0.02362	-0.01187	0.00168	0.0058	-0.1414	**0.41928**	-0.04845	-0.06462	0.17069	0.06108	0.02858	0.03932
Spike length	-0.05051	-0.00216	0.00879	0.07248	-0.0722	0.25345	**-0.08016**	-0.49066	1.00974	0.0908	0.06151	0.05608
No. of spike lets per spike	0.01417	0.01095	0.00233	0.02523	-0.06628	0.06597	-0.09576	**-0.4107**	0.61853	0.2921	0.02041	0.06796
No. of grains per spike	-0.04736	0.01138	0.00089	0.01552	-0.05312	0.08571	-0.09693	-0.30422	**0.83501**	0.42433	0.02179	0.04753
Biomass yield(g)	-0.01948	-0.00245	-0.00827	-0.02553	-0.08949	0.0361	-0.01026	-0.16908	0.49938	**0.70953**	-0.03946	0.02787
Harvest index	0.04536	0.0056	0.00441	0.03023	0.04159	0.1347	-0.05541	-0.09423	0.20452	-0.31465	**0.08897**	0.05545
1000 seed weight(g)	0.04246	0.00453	0.00003	0.02416	-0.06465	0.15806	-0.0431	-0.26757	0.38045	0.18956	0.0473	**0.10431**

Table 5. Direct and indirect effects between grain yield per running meter and its components in 30 wheat varieties at phenotypic level Rabi 2022

	Days to 50% flowering	Days to maturity	plant height(CM)	No. of tillers /meter	Flag leaf length(cm)	Flag leaf width(cm)	Spike length	No. of spike lets	No. of grains/ spike	Biomass yield(gm)	Harvest index	1000 seed weight(gm)
Days to 50% flowering	**0.11478**	-0.10093	0.00008	-0.00022	-0.00821	-0.01058	0.00026	0.00071	0.00436	0.06746	-0.0512	0.00801
Days to maturity	-0.07573	**0.30726**	-0.01348	-0.01144	0.00643	-0.18676	0.03307	0.00304	-0.14248	-0.43746	-0.01375	0.01851
plant height(CM)	-0.12771	-0.0476	**0.08701**	-0.04931	-0.01253	-0.15093	0.09803	0.00625	-0.16432	1.16788	-0.13615	0.00016
No. of tillers per running meter	-0.00501	0.03074	0.03752	**-0.11436**	-0.04426	-0.0555	0.08605	0.00547	-0.12949	0.38388	-0.09935	0.01539
Flag leaf length(cm)	-0.03802	-0.00478	0.00264	-0.01227	**-0.41271**	0.32644	-0.02068	-0.00327	0.18816	0.32464	-0.03297	-0.00994
Flag leaf width(cm)	-0.03099	-0.09588	-0.02194	0.01061	-0.22512	**0.59847**	-0.04488	-0.00193	0.19431	0.08096	0.06603	-0.01502
Spike length	-0.06627	-0.13685	-0.11488	0.13253	-0.11495	0.36176	**-0.07425**	-0.00993	0.68608	0.12035	0.1421	-0.02143
No. of spike lets per spike	-0.02964	-0.09558	-0.05555	0.06392	-0.13774	0.11793	-0.07536	**-0.00978**	0.32748	0.28448	0.00164	-0.02286
No. of grains per spike	-0.07483	-0.07799	-0.02547	0.02638	-0.13835	0.20718	-0.09076	-0.00571	**0.5613**	0.5013	0.05617	-0.01793
Biomass yield(g)	-0.02556	-0.14293	0.10806	-0.04668	-0.14247	0.05152	-0.0095	-0.00296	0.29921	**0.94042**	-0.09115	-0.01065
Harvest index	0.05951	-0.02056	-0.05764	0.05528	0.06621	0.19226	-0.05133	-0.00008	0.1534	-0.41705	**0.20554**	-0.02118
1000 seed weight(g)	0.05571	-0.14273	-0.00035	0.04418	-0.10292	0.22561	-0.03992	-0.00561	0.25256	0.25125	0.10926	**-0.03985**

degree of genetic variability among the genotypes for every trait. The genotypes JW 3020 (343.687) followed by JW 3173 and JW 1215 recorded highest mean performance for grain yield. Grain yield at both genotypic and phenotypic levels was significantly positively correlated with characteristics such as biomass yield (0.891**, 0.511**), number of grains per spike (0.844**, 0.538**), and thousand seed weight (0.544**, 0.359**). Similar pattern of results have also been recorded by [8] and [9]. The character like days to maturity exhibited negative significant correlation with grain yield per running meter at both genotypic and phenotypic levels. (-0.473** – 0.609**) these results are in agreement with earlier reports of [10] and [11].

The ability to respond to the selection process requires genetic variability. It has also been noted that plant breeders must take advantage of the degree of genetic variability found in the base population of any crop species in order to increase yield [12] and [13]. For each of the characters studied, the magnitude of the phenotypic coefficient of variation (PCV) was generally higher than the corresponding genotypic coefficient of variation (GCV).

From the study of Path analysis it was revealed that characters like number of grains per spike (0.835, 0.035), biomass yield (0.71, 0.765) and harvest index (0.089, 0.598) had direct positive effect on grain yield per running meter at both genotypic and phenotypic level supported by [14,15] and [16]. "The characters like days to maturity (-0.005, -0.0055) had negative direct effect on grain yield per running meter at both genotypic and phenotypic level".

4. CONCLUSION

The experimental results indicated that 20 different wheat varieties varied significantly, with variety JW 3020 demonstrating the highest mean performance for grain yield per running meter (343.687gms).Correlation and path analysis revealed that biomass yield number of grains per spike, number of spikelet's per spike, harvest index are the most important component characters that could be used as selection indices for further improvement in grain yield under sub-tropical conditions of Indore region.

DECLARATION

This submitted work has not been published previously (except in the form of an abstract, and an academic thesis), and is not under consideration for publication elsewhere, it's publication is approved by all authors and tacitly or explicitly by the responsible authorities where the work was carried out, and if accepted, it will not be published elsewhere in the same form, in English or in any other language, including electronically without the written consent of the copyright holder.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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