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RESEARCH ARTICLE

YIELD AND YIELD ATTRIBUTING CHARACTER OF NEPALESE WHEAT GENOTYPES UNDER COMBINED RAINFED AND HEAT STRESS CONDITIONS

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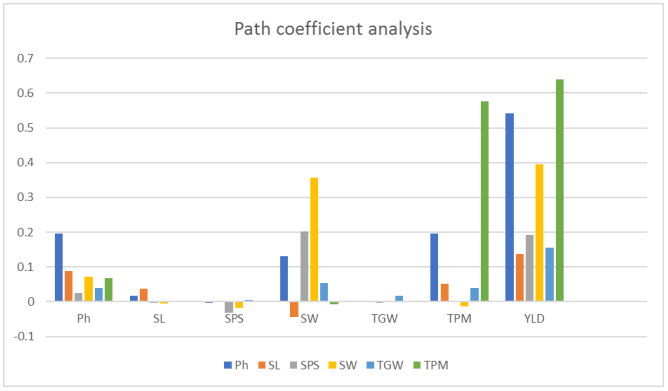
ABSTRACT

Wheat is the third most important cereal crop in Nepal. The area and production of wheat in Nepal has been increased dramatically after the introduction of semi dwarf varieties and now it has significant contribution to the national food supply. The aim of evaluating twenty elite wheat genotypes under combined heat stress condition field research was conducted using alpha lattice design at Bhairahawa, Nepal. The limiting factor of wheat in Nepal is irrigation and heat stress. Heat stress is the critical factor that directly affect the grain yield and productivity of crop. Drought significantly affects the yield of wheat. The selected parameters to determine yield and yield attributing character in wheat were plant height, spike weight, spikelet per spike, thousand grain weight, number of tillers per square meter and yield. The path analysis identified biological yield per plant in tillers per meter square as the major direct positive contribution towards expression of grain yield per plant. The results of correlation showed highly positive significant association with TPM (0.575879) and SW (0.355878) and negative significant association with SPS (-0.03118) can help breeding programs that are subjected to heat stress by revealing which traits have a major impact on yield. The highest positive correlation (.640**) was appeared on tillers per meter square and the negative correlation (-.138) was appeared on spike length. The highest value of direct effect of yield with plant height was followed by TPM and the least value of direct effect of yield was (.138 9). Multilocation and multiyear yield trials are required for more validation of additional trials involving many sites and years are required to confirm the selection of these characteristics for increased yield. The result presented here encourage the productivity in sustainable way in the heat stress and drought farming system.

KEYWORDS

correlation, path coefficient, heat stress, rain fed, grain

1. INTRODUCTION



Graph 1: Graphical Representation

Wheat (Triticum aestivum) is most abundant cereal crop as rice, maize and barley. It is the most popular, oldest and extensively cultivated crop belonging to family poaceae.It can be grown under irrigated ,rainfed and various stress condition. Approximately 2.9 billion tons of grain are produced annually from 718 million hectares of raised grain on the nearly 1.5 billion hectares of farmland in the word (Cançelik et al., 2021). However, 67% of the world's agricultural productivity is now attributed to Asian farmers courtesy to the green revolution. (Mendelsohn, 2014). Wheat production has a significant impact on Nepal's agriculture industry, which contributes 23.5% of the GDP. Among the three agroecological condition terai region is the significant area where over 60% of wheat production occurs. The national production, area and productivity of wheat in the year 2022/23 is1727346 tonne ,716978 hectare and 2144568 tonnes per hectare respectively (Krishi Diary, 2080). The National Agriculture Research Program (NARC) at Bhairahawa, Rupandehi, Nepal is home to the National Wheat Research Program (NWRP), a national commodities research program that has produced high-yielding, disease-resistant cultivars such NL 971, Vijay, Bhrikuti, and Gautam, Aditya, Tilottama, WK1204, BL 1473, Dhaulagiri, Danphe, and so on. Nonetheless, widespread varieties like NL 297, and RR21 were created before to the Nepal Agricultural Research Council (NARC)'s founding.

Wheat is considered a good source of 21%protein, 1.8%minerals, B-group of vitamins and 20%dietary calories,22%crude fibre ,2%fat,12%water. It is an excellent health-building food. Wheat flour is also used for preparing bread, produce biscuits, confectionary products and noodles (Poudel et al., 2017). It has a direct bearing on the nutrition, food security, and rural livelihood of resource-poor farmers in industrialized and emerging nations (Upadhyay, 2020). A breeder receives assistance in determining whether the causal variable's indirect effect or direct effect is responsible for the resulting of variable's association with grain yield (Barman et al., 2020).

The growth, development, and yield of wheat as determined by climate, soil, water, and nitrogen management are replicated by the cropping systems simulation model Agricultural Production Systems simulator (APSIM) methods (Devkota et al., 2024). Climate change is one of the major obstacles facing humanity in the future and effect of climate change has

been adverse to agricultural industry. The mean fluctuation in temperature affect the frequency of severe weather events could pose a greater present danger to food production (Harkness et al., 2020). It is expected that between 2016-2045, the atmosphere would rise by 0.91 to1.07˚c, and that annual precipitation will decrease by 16.093 mm (Poudel et al., 2023). The production of wheat is impacted due to climate change as the temperature is extreme at both summer and winter.

Wheat is grown in many farming communities. Crop productivity and agricultural system efficiency are major concerns in Terai due to the region's shrinking farm sizes. The result of the actions and interactions of several qualities is grain yield. Direct contributing traits include the number of effective tillers per unit area, the number of fertile panicles per unit area, and the 1000-grain weight. features that indirectly contribute, like plant height, spike length, spikelet per spike etc (Khanal et al., 2020). The result of the actions and interactions of several qualities is grain yield (Subedi et al., 2019). The productivity and production of wheat must raised in order to meet the various needs of farmers, address the food security, and provide food for an expanding population (Upadhyay, 2020).

Correlation analysis helps to determine the mutual relationship between yield with its different component traits but correlation alone cannot present the true association of traits with yield due to interrelationship between component traits themselves. Path coefficient is most powerful tool helps to analyze nature, extent and direction of selection. It is used to establish exact relationship in terms of cause and effect, identify the direct, indirect and total causal effect (Khanal et al., 2020). Correlation and path coefficient analysis help to improve selection efficiency in future breeding program based on traits selection. The objectives of the present study aim to determine the correlation and path coefficient analysis of yield and yield attributing traits of wheat genotypes for yield improvement.

2. Method and Methodology

The experiment was carried out at IAAS Paklihawa, Rupandehi which was located at 27c 30 N,83 27 E and 79m above the sea level. A set of 20 genotypes (Table 1) including 12//4 checks viz BL/G/RR21 were obtained from NWRP, Bhairahawa.

Table 1: List of genotypes

SN	Genotypes	Origin
1	BL_5106	Nepal
2	BL_5099	Nepal
3	BL_4984	Nepal
4	BL5116	Nepal
5	Gautam	Nepal
6	Bhirkuti	CIMMYT, Mexico
7	NL 1402	CIMMYT, Mexico
8	NL 1437	CIMMYT, Mexico
9	NL1492	CIMMYT, Mexico
10	NL1488	CIMMYT, Mexico
11	NL1447	CIMMYT, Mexico
12	NL1445	CIMMYT, Mexico
13	NL1506	CIMMYT, Mexico
14	NL1504	CIMMYT, Mexico
15	NL1503	CIMMYT, Mexico
16	NL1501	CIMMYT, Mexico
17	RR21	CIMMYT, Mexico
18	NL1512	CYMMIT, Mexico
19	NL1509	CIMMYT, Mexico
20	NL1508	CIMMYT, Mexico

Source: National Wheat Research Program (NWRP), Bhairahawa

The experiment was carried out in alpha lattice design replicated two times in five blocks. The size of plot was 5m2(2.5m*2). The inter plot was 0.5m and inter block was 0.5m. sowing was done on 26 December following line sowing. The planting space is maintained as per the standard recommendation. The data collected were plant height (Ph), spike weight, spikelet per spike, thousand grain˚weight, number of tillers per square meter, total yield. The heat stress condition in field was created by sowing wheat genotypes one month later (26 Dec) than the standard sowing time (25 November) so as to blow heat waves of March- April to the reproductive stage of wheat crop later (26 Dec) than the standard sowing time (25 November) so as to blow heat waves of March- April to the reproductive stage of wheat crop.

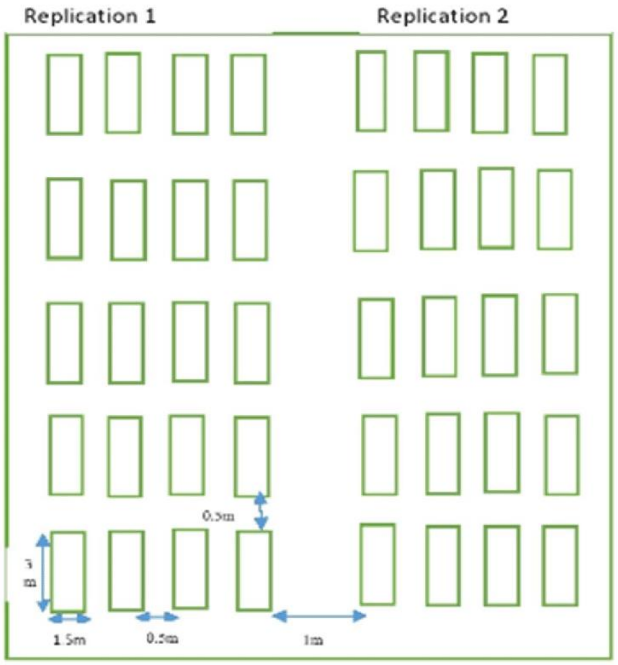


Figure 1: Alpha Lattice Design of experimental plot

The statistical analysis was done by using Microsoft -excel 2019 for data entry and path analysis of correlation between various agromorphological yield and yield attributing character was done by SPSS software version 20. The statistical analysis was declared at 5% level of probability.

3. Result and Discussion

The correlation coefficient is the measure of degree of symmetrical association between two variables or characters and help us in understanding the nature and magnitude of association among yield and yield components. Plant height showed a significantly highly positive correlation with SL, SW and YLD and non- significantly positive correlation with SPS, TGW and TPM (Table 2). A longer stem height increases yield in heat stress condition because it permits appropriate florets development and the upward expansion of developing wheat spikes inside the stem for spikelet differentiation.

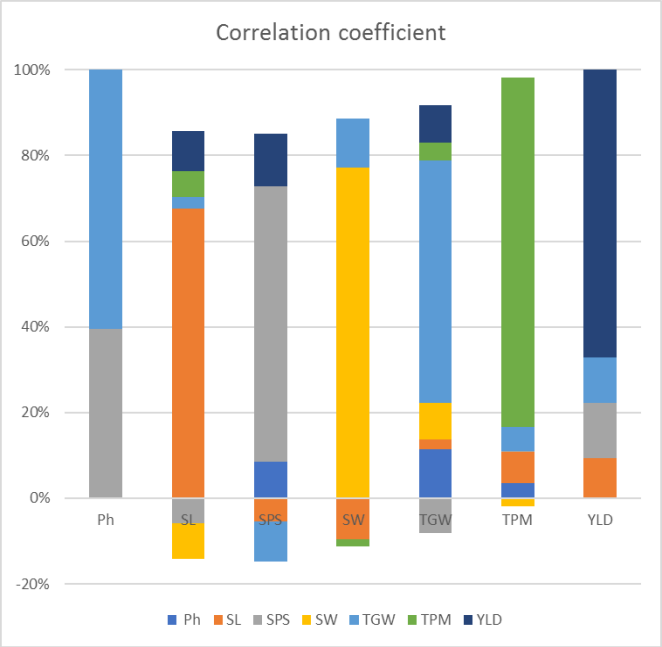
Spike length showed significantly highly positive correlation with Ph and non-significant positive correlation with TGW, TPM and YLD. It showed a non- significantly negative correlation with SPS, SW. Spikelet per spike showed a significantly highly positive correlation with SW and non - significantly positive correlation with SL, TGW and YLD. It showed non-significant negative correlation with PH,TPM The obtained result is the longer the spike more will be the photosynthates which is directly associated with yield (Poudel et al., 2023).

Spike weight showed significantly highly positive correlation with SPS and significantly positive correlation with Ph and YLD. According to Teng et al. 2023 reduced photosynthetic activity hinders net photosynthesis, and starch synthase activity decreases net starch accumulation on the grain during grain filling period. It showed a non-significantly positive correlation with SL and TPM. Thousand grain weight showed a significantly positive correlation with Ph, SL, SW, TPM, YLD and non-significantly negative correlation with SPS.

Tillers per meter square showed significant highly positive correlation with YLD and significantly positive correlation with Ph. It showed a non-significantly positive correlation with SL SPS, TGW and showed a non - significantly negative correlation with SW, Ph, SL and TPM ,under drought stress condition were found to be positively and significantly linked with grain yield (Subhani and Chowdhry, 1999). The number of spikelets per spike had a positive correlation with the total grain weight. During flowering, heat stress reduces the grain number per spike because of pollen abortion and grain sterility (Razeal et al., 2018).

Table 2: Correlation coefficients of yield and yield attributing traits of wheat.							
	Ph	**SL**	**SPS**	**SW**	**TGW**	**TPM**	**YLD**
Ph	1	.451**	.132	.370*	.202	.042	.542**
SL	.451**	1	-.086	-.125	.039	.091	.138
SPS	.132	-.086	1	.570**	-.145	.001	.193
SW	.370*	-.125	.570**	1	.149	-.022	.396*
TGW	.202	.039	-.145	.149	1	.070	.156
TPM	.342*	.091	.001	-.022	.070	1	.640**
YLD	.542**	.138	.193	.396*	.156	.640**	1

Where, Ph=plant height, SL=spike length, SPS=spikelet per spike, SW=spike weight, TGW=total grain weight, TPM=tillers per meter square, YLD=yield



Graph 2: Correlation coefficient

The path coefficient analysis squeal on total correlation coefficient of different parameters into direct and indirect on grain yield in such a manner that the sum of direct and indirect effect is equal to total genotypic correlation. The positive and negative values of parameters determine the direction of yield whether it increases or decreases when they are changes in the parameters. Path coefficients analyzed that spike per plant, grains per spike, 100-grain weight and spike weight were the most important characters as they exhibited high direct effects on grain yield per plant. Plant height (0.196784) followed by spike length (0.038391), thousand grain weight (0.016751) had positive direct effect on the yield of grain. The increase in plant population had direct influence in the yield of crop.

Spikelet per spike had negative direct effect by grain yield per plant. The reproductive phase are intended the most critical stage in wheat, under heat stress condition the development of female reproductive organ get demolished cause the sterility in spikelet which directly affect the yield (Farhad et al., 2023). Spike weight had direct positive effect on grain yield (0.0389). Spike weight is increased with increase in number of spikelet per spike with has direct association with grain yield as reported (Poudel et al., 2021). Thousand grain weight showed an positive direct effect on grain yield (0.001176).

According to a srudy, the direct effect of thousand grain weight upon grain yield was high and positive but due to heat stress rainfed there had low positive effect on grain yield (Chowdhry et al., 1986). Tiller per meter square had highly direct positive association with grain yield (0.5758). Highest positive direct effect (0.575879) on grain yield was exhibited by TPM (Table 3). A group researchers also revealed similar result in wheat and strong association with grain yield and the second highest positive direct effect by SW (0.355878) which indicates the two parameter affects the grain yield (Table 3) therefore, it is speculated that breeding programs are bound to select for these traits so as to improve production (Nukasani et al., 2020).

Table 3: Path coefficient analysis of yield and yield attributing of wheat						
	Ph	**SL**	**SPS**	**SW**	**TGW**	**TPM**
Ph	0.196784	0.088749	0.025922	0.07281	0.039749	0.0673
SL	0.017314	0.038391	-0.00332	-0.00481	0.001509	0.003475
SPS	-0.00411	0.002694	-0.03118	-0.01777	0.00452	-4.3E-05
SW	0.131675	-0.04463	0.20285	0.355878	0.053092	-0.00779
TGW	0.003384	0.000658	-0.00243	0.002499	0.016751	0.001176
TPM	0.196951	0.052126	0.000803	-0.0126	0.040423	0.575879
YLD	0.542	0.137988	0.192652	0.396	0.156043	0.64

Where, Ph=plant height, SL=spike length, SPS=spikelet per spike, SW=spike weight=tillers per meter square, TPM=tillers per meter square, YLD=yield,

4. Conclusion

Wheat is the dominating crop contributing globally a significant affect in food security and food sovereignty. The result of current study showed that the more the number of tiller and spike weight the more will be the yield. The information so derived could be exploited in devising further breeding strategy and selection procedure develop new varieties capable of high yield. The prime motive of present analysis is to determine the yield and yield attributing characters of wheat genotype under heat stress rainfed condition. The grain yield has a positive correlation with TPM and SL, which also showed high direct effect through the path analysis where it has a negative correlation with SPS. The path coefficient analysis showed the highest negative direct effect on grain yield by SPS. Timely sowing of wheat increases number of tillers, spikes, grains per spike and grain weight, which ultimately increases the grain yield. It has a direct bearing on the nutrition, food security, and rural livelihood of resource-poor farmers in industrialized and emerging nations. The above information so derived could be exploited in devising further breeding strategy and selection procedure develop new varieties capable of high yield. To meet the varied wheat output and productivity must rise in order to meet farmer needs, address the issue of food security, and provide food for a growing population.

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