Research Article

Response of Different Wheat Genotypes to Aphids Infestation Under Irrigated and Rainfed Conditions

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Abstract | Aphids are common wheat and barley pest in many parts of the world including Pakistan. This experiment was conducted at the experimental field of the department of Plant Breeding and Genetics, The University of Agriculture Peshawar, Khyber Pakhtunkhwa, Pakistan during 2014-15 and 2015-16. Eight bread wheat (*Triticum aestivum* L.) varieties i.e., Atta-Habib (AH), Lalma-13 (Lal-13), Tatara-96 (Tat-96), Punjab-11 (PJ-11), Pirsabak-2005 (PS-05), Pirsabak-2013 (PS-13), Janbaz (JB) and land race Khatakwal (KW) were crossed in 8×8 full diallel pattern to identify aphids resistant genotypes under irrigated and rainfed conditions. Number of aphids tiller^{-1} revealed highly significant differences ($P \leq 0.01$) among the genotypes. Under irrigated condition genotypes PJ-11×Lal-13, Tat-96×Lal-13, JB×Lal-13, AH×PS-05 and PS-13×Lal-13 were comparatively resistant with low aphids density while genotype PJ-11×PS-05 and KW were most susceptible. Under rainfed condition genotypes JB×Lal-13, PJ-11×Lal-13, AH×PS-05, Tat-96×Lal-13 and PS-13×Lal-13 were comparatively resistant while genotypes PS-05×KW and PS-05 were most susceptible. Comparatively less aphids tiller^{-1} were observed under irrigated condition in all three scoring dates. Highest aphid's infestation was recorded on average temperature of 24.8°C. On the basis of field scoring resistant genotypes were identified which are prerequisite for further molecular and biochemical study to explore resistance pathway. These lines could be used as a source of aphids resistance in future wheat breeding program.

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Introduction

Aphids are common wheat and barley pest in many parts of the world (Sánchez-Monge et al., 2010) and attained the status of a regular pest in Pakistan (Zeb et al., 2011). Aphids are commonly called plant lice which cause serious yield losses in cereal crops (Bhagat, 2012). Along with plant injury and sucking juice, aphids also play the role of vector for more than 50% of the 600 viruses and transmit pathogens in host plants (Sarwar, 2013; Sudderth and Sudderth, 2014). In crops, 25 out of 29 wheat aphids species transmit viral diseases (Islam et al., 2015). Different environmental conditions alter aphids feeding behavior and movement among the host plants. Aphids feeding cause leaf rolling, longitudinal leaf chlorosis, reduced root and tiller development, stunting and even death of plant which ultimately reduce grain yield (Nicholson et al., 2012). Yield losses of 20-30% were reported in case of 100 aphids plant^{-1} while more infestation some time cause complete failure of crop (Sarwar, 2013). Polycultures reduce pest population due to abundance of natural enemies which decrease colonization and reproduction of pests (Dahlin and Ninkovic, 2013). While through associational resistance of some plants, neighboring crop decrease the amount of yield losses caused by aphids (Dahlin and Ninkovic, 2013). Host plant and climatic conditions play a vital role in spreading of aphids population (Şenol et al., 2014). Synthetic insecticides provide quick and adequate Aphids control (Nas, 2004) but they are expensive, develop resistant to insecticides, hazardous to environment and non-target insects and cause environmental pollution (Sarwar, 2013; Singh et al., 2012). Among the prevention strategies host plant resistance is the most effective method of aphids control (El Bouhssini et al., 2011). Although, genotypic diversity and intraspecific variation in host-plant affect the structure of associated arthropod communities (Genung et al., 2012). Plants evolve mechanical adaptations such as thorns, trichomes, lignins, silicates and allelochemicals like phenol, alkaloid and proteins to prevent herbivory (Wittstock and Gershenzon, 2002). Thus the present study was designed to identify Aphids resistant genotypes for irrigated and rainfed conditions.

Materials and Methods

This experiment was conducted on eight wheat (*Triticumaestivum*L.) varieties i.e., Atta-Habib (AH), Lalma-13 (Lal-13), Tatara-96 (Tat-96), Punjab-11 (PJ-11), Pirsabak-2005 (PS-05), Pirsabak-2013 (PS-13), Janbaz (JB) and land race Khatakwal (KW) and their 56 F_1 hybrids as developed by 8×8 full diallel pattern. Trail was conducted at the Department of Plant Breeding and Genetics, The University of Agriculture, Peshawar during 2014-15 and 2015-16. All the crosses and their parents were tested for aphids infestation under irrigated and rainfed conditions in adjacent field to avoid environmental bias. Both experiments were laid out in randomized complete block design with three replications. Number of rows was two in each entry with row length of two meters. Row to row and plant to plant distances were maintained 30 and 15 cm, respectively. Recommended inputs and standard agronomic practices were applied. Precipitation data during the crop season was obtained from meteorology department regional office Peshawar. Aphid's population were scored on five randomly selected tillers on three dates with interval of 10 days in the field as described by Aheer et al. (2007) and Zeb et al. (2011). The average number of aphids tiller^{-1} for each variety/line was calculated according to Iqbal et al. 2008. The collected data were subjected to analysis of variance (ANOVA) according to Steel and Torrie (1980).

Results and Discussion

Table 1: *Analysis of variance (ANOVA) for number of aphids tillers^{-1} under irrigated and rainfed conditions.*

Aphids tiller^{-1}	Reps (d.f= 2)	Genotypes (d.f= 126)	Error (d.f=126)	CV
Irrigated	21.97	13.85**	4.50	36.77
Rainfed	11.96	8.81**	2.01	37.24

Table 2: *Pooled analysis of variance for number of aphids tillers^{-1} under irrigated and rainfed conditions.*

	Environment (E)	Reps(Env)	Genotypes(G)	G × E	Pooled error
Character	(D.F=1)	(D.F= 4)	(D.F=63)	(D.F= 63)	(D.F= 252)
Aphids tiller^{-1}	371.43 **	16.97	15.67**	6.99**	3.257

Table 3: *Average number of Aphids tiller^{-1} under irrigated and rainfed conditions on 64 wheat genotypes.*

Genotype	Irrigated	Rainfed	Genotype	Irrigated	Rainfed
AH	5.33	6.22	PJ-11×PS-13	3.00	4.22
Lal-13	6.67	7.44	PJ-11×KW	4.33	4.33
Tat-96	4.67	4.33	PJ-11×JB	5.11	6.33
PJ-11	5.33	5.00	PS-05×AH	2.22	6.33
PS-05	5.00	8.67	PS-05×Lal-13	3.56	3.00
PS-13	4.00	8.00	PS-05×Tat-96	3.78	7.00
KW	7.33	8.56	PS-05×PJ-11	4.89	6.33
JB	4.78	7.44	PS-05×PS-13	2.33	4.44
AH×Lal-13	2.33	5.56	PS-05×KW	4.89	10.22
AH×Tat-96	1.22	5.56	PS-05×JB	3.78	7.22
AH×PJ-11	2.22	6.56	PS-13×AH	3.22	4.00
AH×PS-05	0.78	0.56	PS-13×Lal-13	1.11	0.67
AH×PS-13	1.67	8.56	PS-13×Tat-96	4.11	5.22
AH×KW	6.33	5.11	PS-13×PJ-11	1.67	8.11
AH×JB	6.33	4.22	PS-13×PS-05	4.11	6.33
Lal-13×AH	6.00	5.67	PS-13×KW	3.78	8.33
Lal-13×Tat-96	2.44	3.89	PS-13×JB	2.00	5.33
Lal-13×PJ-11	4.33	7.56	KW×AH	3.78	6.00
Lal-13×PS-05	4.22	4.78	KW×Lal-13	4.78	7.11
Lal-13×PS-13	2.33	5.67	KW×Tat-96	5.67	6.33

Links Researchers

Lal-13×KW	2.00	7.56	KW×PJ-11	3.67	4.56
Lal-13×JB	3.56	6.78	KW×PS-05	3.78	6.56
Tat-96×AH	3.11	4.22	KW×PS-13	6.33	8.22
Tat-96×Lal-13	0.44	0.67	KW×JB	3.22	8.00
Tat-96×PJ-11	4.11	6.33	JB×AH	2.89	5.78
Tat-96×PS-05	6.89	5.11	JB×Lal-13	0.78	0.33
Tat-96×PS-13	6.22	4.67	JB×Tat-96	2.67	5.11
Tat-96×KW	4.44	7.89	JB×PJ-11	3.11	5.44
Tat-96×JB	3.11	7.33	JB×PS-05	4.33	4.78
PJ-11×AH	4.67	8.33	JB×PS-13	4.11	5.11
PJ-11×Lal-13	0.33	0.44	JB×KW	2.33	8.22
PJ-11×Tat-96	4.44	7.56	LSD	1.63	2.25
PJ-11×PS-05	7.56	4.22			

The experiment was conducted on 64 wheat genotypes to identify Aphids resistant genotypes under irrigated and rainfed conditions. Number of aphids tiller^{-1} revealed highly significant differences ($P \leq 0.01$) among the genotypes under both condition (Table 1). Similar findings of significant variation among the genotypes for aphids population were also reported by Dahlin and Ninkovic (2013), Iqbal et al. (2008) and Jarošík et al. (2003). Genotype by environment interaction (G×E) was also highly significant (Table 2) which is the conformity of the findings of Bruce et al. (2003). Evaluation of wheat germplasm across different environments is very important because significant G×E interaction change the rank of genotype across the environment (Ma and Singh, 1996). Maximum 7.56 aphids tiller^{-1} were observed on genotype PJ-11×PS-05 followed by KW (7.33 aphids tiller^{-1}) and Tat-96×PS-05 (6.89 aphids tiller^{-1}) and remained the most susceptible while minimum 0.33 aphids tiller^{-1} were recorded on PJ-11×Lal-13 followed by Tat-96×Lal-13 (0.44 aphids tiller^{-1}), JB×Lal-13 (0.78 aphids tiller^{-1}), AH×PS-05 (0.78 aphids tiller^{-1}) and PS-13×Lal-13 (1.11 aphids tiller^{-1}) were found comparatively resistant among the studied genotypes under irrigated condition (Table 3). Under rainfed condition. The most susceptible genotypes with maximum (10.22) aphids tiller^{-1} was observed on genotype PS-05×KW followed by PS-05 (8.67 aphids tiller^{-1}), KW (8.56 aphids tiller^{-1}) and AH×PS-13 (8.56 aphids tiller^{-1}). While minimum 0.33 aphids tiller^{-1} was recorded on partially resistant genotype JB×Lal-13 followed

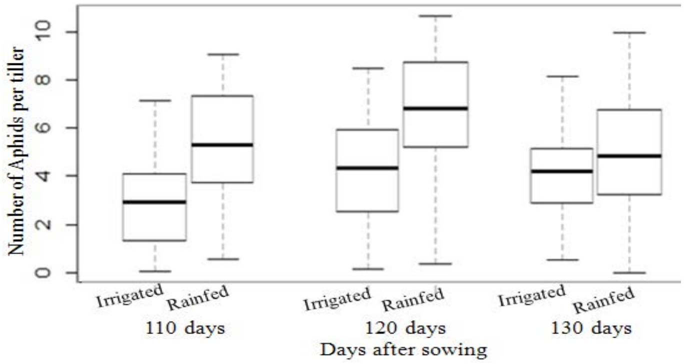

Figure 1: *Number of aphids tiller^{-1} on 64 wheat genotypes under irrigated and rainfed conditions.*

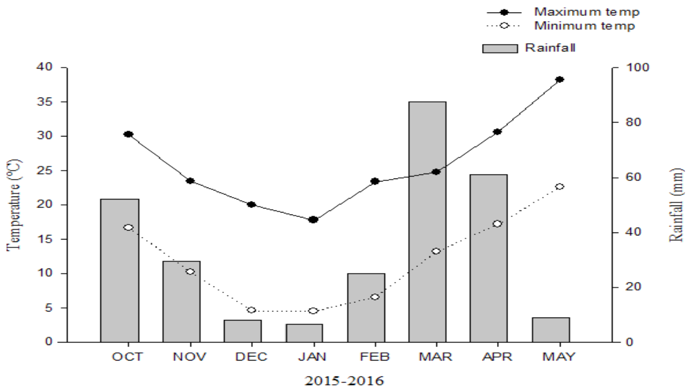

Figure 2: *Monthly temperature (°C) and rainfall (mm) of the experimental site during growth season.*

by PJ-11×Lal-13 (0.44 aphids tiller^{-1}), AH×PS-05 (0.56 aphids tiller^{-1}), Tat-96×Lal-13 (0.67 aphids tiller^{-1}) and PS-13×Lal-13 (0.67 aphids tiller^{-1}) among the 64 wheat genotypes (Table 3). Similar findings of significant variation in aphids population on different wheat genotypes were also reported by El Bouhssini et al. (2011), Mondor et al. (2007), Ochieng and Nderitu (2011) and Sarwar (2013). Number of aphids tiller^{-1} was counted after 110, 120 and 130 days of sowing in the first, second and third scoring, respectively. Comparatively more aphids tiller^{-1} were observed under rainfed condition than irrigated in all the three scoring dates (Figure 1). Upward trend in aphids population was observed on majority of wheat genotypes till second scoring except PJ-11, AH×PS-05 and KW×PJ-11 (Figure 3). While decreasing trend in aphid's population was observed during third scoring on majority of genotypes except Lal-13×PS-05, Tat-96×PS-05 and PJ-11×PS-13 (Figure 3). During second scoring in March 2016 maximum temperature (24.8°C) was coupled with precipitation of 87.6 mm while in third scoring temperature was 30.6°C and precipitation was 61.0 mm (Figure 2).

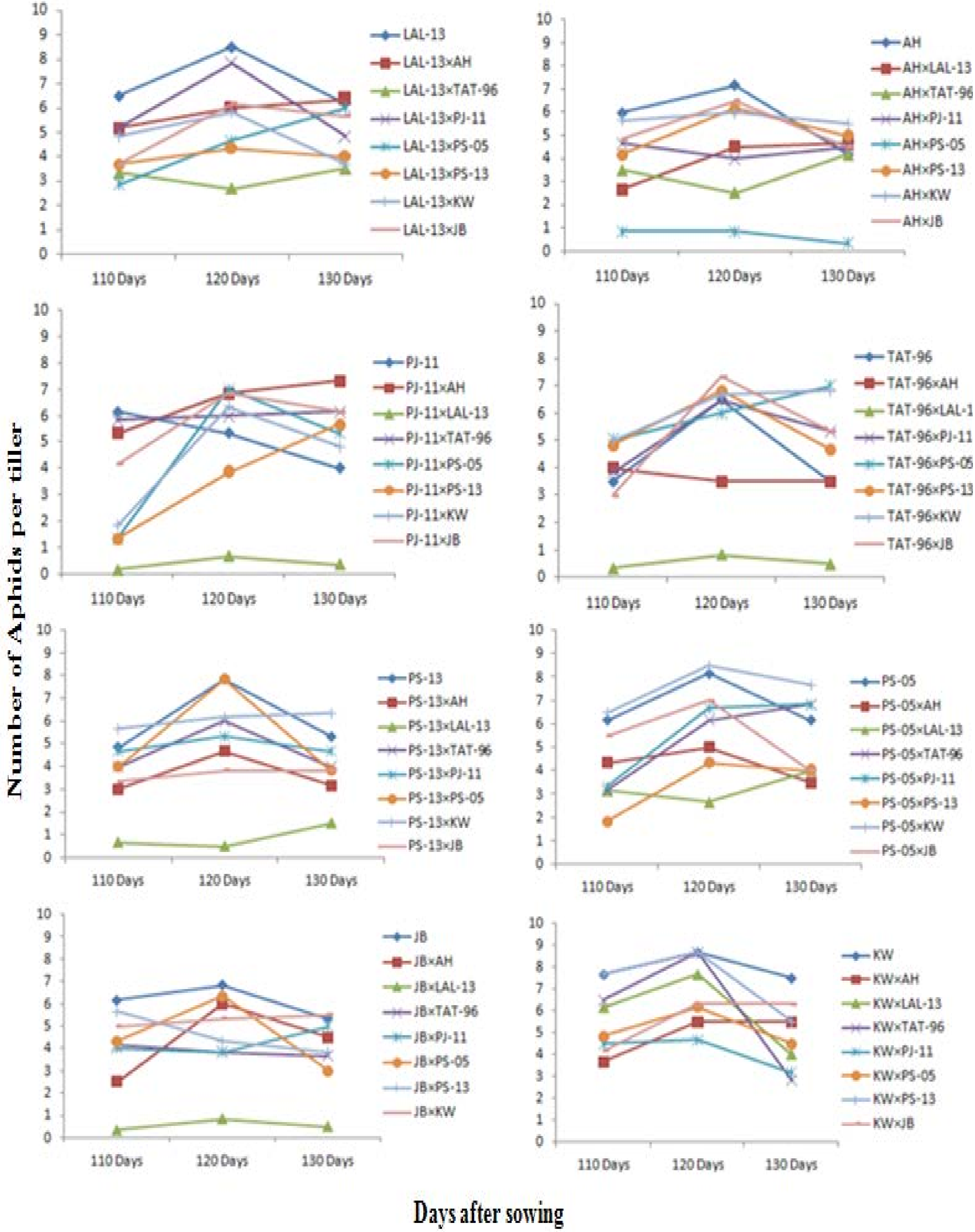

Figure 3: *Average number of aphids tiller⁻¹ across location during three scoring dates.*

Similar findings of fluctuation with temperature in aphids population were also reported by Bruce et al. (2003), Johnson, Anonymous, Messina and Bloxham (2004) and Wains et al. (2010). Climatic factors also

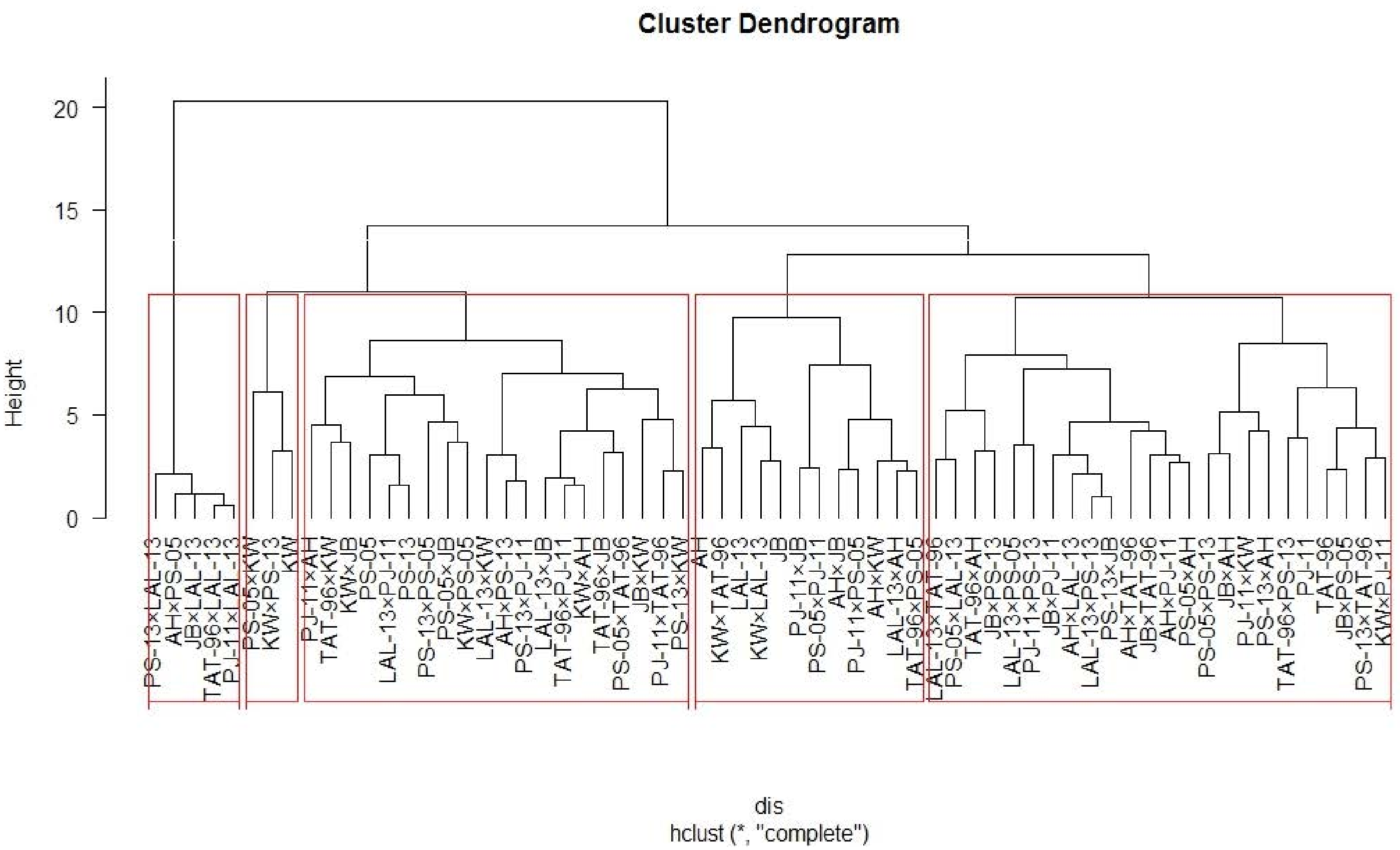

Figure 4: *Cluster analyses for number of aphids tiller^{-1}.*

influence aphids population which increase or decrease aphids population but in this experiment all the genotypes were exposed to similar climatic conditions. In similar condition the presence of significant variation in aphids population among the genotypes showed variation in level of resistance in these genotypes, i.e., PJ-11×Lal-13, Tat-96×Lal-13, JB×Lal-13, AH×PS-05 and PS-13×Lal-13 and also grouped them into sub cluster 1. Three, twenty, twelve and twenty four were grouped into second, third, fourth and fifth sub cluster respectively (Figure 4). Such partial resistance are due to mechanical adaptations of plant or production of allelochemicals to prevent herbivory (Wittstock and Gershenzon, 2002). Among the studied genotypes several partially aphids resistant genotypes were identified on the basis of field scoring which is prerequisite for further molecular and biochemical study. These genotypes could be used in future as a resistance source in wheat breeding program to develop aphids resistant variety for commercial cultivation.

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Author's Contribution

Sher Nawab Khan: Conducted the experiment, compiled and analysed the results and wrote the paper.
Ghulam Hassan: Designed the experiments, proofread and revised the manuscript.

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