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Evaluation of Wheat Genotypes Against Russian Wheat Aphid, Diuraphis Noxia (RWA) Under Irrigated Condition in Ethiopia

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Abstract:
Among the many constraints for wheat production, Russian wheat aphids/ RWA cause severe damage by their feeding and by virus transmission. Wheat wild relatives and landraces are potential sources of resistance to aphids. Formerly research result found that RWA populations originated from Chile, Czech Republic and Ethiopia were virulent to Dn4, which is the resistance gene most widely deployed in wheat cultivars, however, Dn6 so far persists to be effective. Hence this study designed for the identification of moderately resistance of xxx bread wheat/Triticum aestivum genotypes at kulumsa, South Eastern Ethiopia. The present study conducted during 2021 and 2022 using irrigation water suggested two genotypes(5010 and 8390) as MR/Moderately resistant candidate compared to wane/check, AS compared to the Moderately susceptible/MS check Balcha, nine as MS/moderately susceptible(204379, 231632, 204379, 230687,5022,231832,235037,234250 and 5694) bread wheat genotypes which are as a candidate as a source of resistance to Russian wheat aphids for future wheat breeding Programme in addition to other protocols to be investigated i.e.; green house, genotyping using known markers, investigating their physio chemical quality parameters.

Keywords: evaluation, RWA, bread Wheat, genotypes, moderately resistance.

INTRODUCTION

Russian wheat aphid Diuraphis noxi (RWA) is one among the important biotic stress result to the reduction of yield and yield attributes in Ethiopia1. It is one of the world's most economically important pests of barley (Hordeum vulgare), wheat (*Triticum aestivum*) and other cereal grains, affecting more than 140 species of grasses within the Poaceae (or graminis) family2.Aphids may infest host plants at any stage of plant development and RWA feeds on the leaves, flowers and seed heads of grasses, with colonies preferring the youngest leaves3. The aphid's Life span was shown to decrease with increasing temperature from 5 to 30oc, but nymph production was shown to increase from 5 to 20 oC4. In their native range, RWA are holocyclic and therefore they can reproduce both sexually (usually for over wintering as eggs) and asexually (mostly during the warmer months). The eggs hatch in early spring and aphid population increases rapidly by parthenogenesis reproduction5.The RWA causes economic damage to wheat in many parts of the world. Earlier reports on losses caused by this aphid on rain fed indicate that it can cause complete crop failure in late planted durum wheat in certain years and locations6.On the other hand RWA is a serious pest of irrigated wheat in Ethiopia, causing substantial wheat yield losses of 69-93%7.Russian wheat aphid can be detected in cereal crops by visual examinations, Plants shows characteristic symptoms such as chlorosis; necrosis ;wilting, stunting; leaf streaking with whitish, yellow and purple longitudinal leaf markings, trapped awns (which give a hooked appearance).

Stunted growth, rolled leaves and heads that fail to flower8.Rolling of the leaves reduces photosynthetic area and protects aphids from contact insecticides and natural enemies9. Both contact insecticides and natural enemies are not effective against the RWA as it feeds within leaf whorls and rolled leaves. Host plant resistance is the most sustainable, cost effective and environmentally safe way of controlling RWA10.Russian wheat aphid favored by dry, warm conditions11, hence evaluation of wheat genotypes to Russian wheat aphid under irrigated condition is pivotal. In Ethiopia Russian wheat aphids and the reaction of different wheat genotypes were not yet identified and lacking. Due to the above facts the following objective of Evaluation, identification and recommendation of moderately resistant wheat genotypes against Russian wheat aphids.

MATERIALS AND METHODS

Description of the Study Area

The study was conducted at Kulumsa Agricultural Research Center in 2021/2022 under irrigated condition. The representative agro ecology of Kulumsa characterized as water logged Vertisols (table 1).

Table 1: The experimental sites and their agro ecological descriptions

Location	Latitude	Longitude	Altitude/m.a.s.l	RF/Mean	Min temp.	Max.temp.	soil texture	PH
Kulumsa	08005'N	39010'E	2200	820	10.5	22.8	Dark-clay loam	6

Source 12

Experimental Materials and Testing Procedure

To total of xxx Wheat genotypes including two checks were tested for Russian Wheat aphid resistance. The non-check genotypes were sourced from Ethiopian Biodiversity institute (EBI) and the checks were obtained from Kulumsa Agricultural Research Center. The experiment was conducted with a Plot size of two rows of one meter plot length and the treatments were arranged in RCBD design with Spacing between row 0.2m and 0.4m between plots. The seed and fertilizer rate were as per the national recommendation for the crop, i.e., 125kg/ha of seed, 125kg for NPS and 100 kg UREA per hectare. Half the rate of Urea and full dose DAP were applied at planting time and the second half of UREA applied on the second round at booting stage and the experimental field was watered using flood irrigation system.

Data Collection

Tiller Number:

Data on number of RWA per 20 randomly selected tillers per plot in a crossed diagonal line at weekly intervals.

Height (cm):

Height of plant before maturity, mean of five random plants measured in cm from ground to tip of spike, excluding awns.

Chlorosis (0-9 scale):

0 = plants are healthy,1= few isolated chlorotic spots and slightly folded leaves, 2 = slightly increase in isolated chlorotic spots and slightly folded leaves,3= chlorotic spots larger and more numerous with slightly enfolding of leaves,4= chlorosis in about 25% of the leaves and increased level of enfolding of leaves,5=merging of chlorotic spots with apparent streaking parallel to and

on either sides of the midribs and pronounced enrolling of leaves,6= distinct streaking parallel to and on either sides of the midrib and enrolled leaves with leaf die back symptom from tips,7 = extensive leaf streaking and enrolled leaves with leaf die back,8=more than 80% chlorotic and enrolled leaves with leaf die back and stunted growth ,9=plants are dying or already dead.

Thousand Seed Weight (TSW):
The weights of thousand seeds were determined by carefully using a seed counter, adjusting to 12.5% moisture content and weighing them using sensitive balance.
Grain yield (GY): Grain yield in g/plot at 12.5% moisture content was recorded and converted to kg/ hectare.

DATA ANALYSIS

Analysis of variance and mean separation were performed following the procedures of Gomez and Gomez (1984) and using SAS version 9.3 and Tukey test for mean separation13 and Minitab software version 17.

RESULT DISCUSSION

Field Performance

The study was conducted for two production seasons (2021 and 2022) using irrigation water at Arsi (Kulumsa), South Eastern Ethiopia. The experimental site suggested as prone for the Russian wheat aphid infestation. Wheat collections obtained from Ethiopian Bio Diversity Institute excluding two checks, taken from Kulumsa Agricultural Research center were used in the experiment. During the experiment field preparation, layout, seed sowing, fertilizer applications, weeding and physiological and field RWA infestation data scoring were undertaken across each plot. The RWA infestation data was taken five times with ten days intervals starting to the startup of the pest symptom seen.

Analysis of Variance/ANOVA

Combined ANOVA of Russian wheat aphid/RWA infestation and agronomic parameters showed significant variation among evaluated xxx treatments except RWA chlorosis. This may be due to the evaluated genotypes resistance variability against RWA infestation. The analysis of variance showed highly significance difference at (P<0.01) as illustrated in table (2) below.

Table 2: Summary of ANOVA table for yield and yield traits

SV	Tiller	height	Chl	TKw	yield
Rep (DF=2)	2	304.34	6	392.56	318.63
Treatment (DF=29)	2*	242.52**	1ns	39.93**	35.32**
Error (DF=58)	9	189.4	1	69.68	78.31
Mean	6	96.211	1	34.478	36.557
CV %	15	14.3	114	24.21	19.01

Key: CV= Coefficient of variations, *= Significant at P < 0.05 and **= significant at P< 0.01, Ns (non- significant) at P>0.05.

Yield and Yield Attributes

Among xxx evaluated wheat genotypes compared to moderately resistance/wane and moderately susceptible/Balcha checks 11 genotypes i.e., 5010, 8390,204379, 231632, 204379,230687,5022,231832, 235037, Kubsa and 5694 yields from 38.05 up to 55.52 Quantals per hectare/ see table 3

Table 3: Mean separation for different traits of evaluated bread wheat genotypes

No	Genotypes	# tillers	height (cm)	Chl (%)	TKw / g	GY/ kg / ha-1
1	231818	7d	86.67	1.3333bc	27.56b	41.27abcd
2	Balcha	7.333cd	84.33cd	3.3333a	28.46b	36.943d
3	231630	8.667abcd	106abc	0.3333bc	38.457b	51.96abc
4	231257	8.333abcd	87.67cd	1.3333bc	31.523b	43.553abcd
5	231638	8.667abcd	90.67abcd	0.6667bc	32.473b	44.63abcd
6	226261	9abcd	82d	0.6667bc	30.813b	48.21abcd
7	5694	8.333abcd	95.67bcd	1.6667abc	28.54b	38.05cd
8	235038	8bcd	96.67abcd	1.3333bc	29.413b	40.843bcd
9	234250	7d	88.33cd	1bc	34.943b	43.22abcd
10	Wane	10.333a	100.33abcd	0.6667bc	37.573b	54.24ab
11	231832	8.667abcd	102abcd	1bc	34.737a	49.107abcd
12	235037	8.333abcd	91.33cd	0c	30.803b	49.85abcd
13	230687	8.667abcd	104.67abc	0.6667bc	36.48b	50.97abcd
14	5001	9.333abc	100abcd	1bc	37.403b	44.887abcd
15	5010	10.333a	116.67ab	0c	39.777b	55.52a
16	8390	10ab	106.33abc	0.3333bc	38b	47.487abcd
17	231578	7d	100abcd	1.3333bc	36.403b	44.163abcd
18	231485	8.667abcd	91.33cd	1.6667abc	37.183b	42.14abcd
19	234267	9.667ab	100abd	1.6667abc	35.04b	45.817abcd
20	241688	8bcd	90cd	2ab	34.777b	45.433abcd
21	204379	9.333abc	100abcd	0c	38.44b	52.17abc
22	231215	9.333abc	105abc	1bc	39.54b	45.62abcd
23	231632	8.667abcd	118.33a	0.6667bc	39.357b	52.207abc
24	7310	8.333abcd	96.67abcd	1	34.57b	47.227abcd
25	234240	8bcd	96.67abcd	1.3333bc	26.4b	40.887bcd
26	222240	7d	90.67cd	1bc	33.09b	43.08abcd
27	231609	8.333abcd	84cd	0.6667bc	32.397b	49.89abcd
28	226675	8.333abcd	88.33cd	2ab	33.53b	48.827abcd
29	231472	8bcd	89cd	1bc	36.11b	47.923abcd
30	5022	8.333abcd	97abcd	1bc	39.533b	50.58abcd
Mean		9	96.211	1	34.478	46.557
CV %		15	14.3	114	24.21	19.01

DISCUSSION

Tolerance is related to plant responses to insect damage, its measurement greatly depends on the aphid species that is being evaluated. Yield losses in the susceptible genotypes related to aphid density comparing with uninfected genotypes in terms of pest and yield and yield attributes. Plant resistance is defined as the genetically inherited traits in a plant of a population or a race or variety of a certain species; resulting in less damage than in other (susceptible) individuals which lack these genetic characteristics. A fundamental point is how to accurately identify resistant genotypes using the proper protocols or screening methods of moderately resistant genotypes against Russian wheat aphid under field condition. In this study in addition to visual plant symptoms, yield and yield component parameters (tiller number, height, leaf rolling, chlorosis, thousand seed weight and yield per hectare) were used to evaluate sown wheat genotypes during the 2021 and 2022 under irrigated condition.

CONCLUSION AND RECOMMENDATION

Based on the evaluation two genotypes (5010 and 8390) as compared to MR check, Wane were categorized as MR/moderately resistant and nine genotypes were grouped as MS/moderately susceptible (204379, 231632, 204379, 230687,5022,231832,235037,234250 and 5694) and the rest as susceptible among the evaluated bread wheat genotypes. The study result suggests the MR and Ms categorized above genotypes are suggested for further breeding Programme in addition to green house, genotyping using known markers, investigating their physio chemical quality parameters to confirm the resistant gene carried in future RWA resistance breeding.

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