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Evaluation of Different Groundnut *Arachis hypogea* L. Cultivars Against Termites, *Odontotermes obesus* (Rambur) in Rawalpindi, Pakistan

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ABSTRACT

Six groundnut (*Arachis hypogea* L.) cultivars i.e. Golden, BARI-2000, Australian, BARD-479, ICG-7326 and 2KCGC20 were evaluated against the attack of *Odontotermes obesus* in terms of percentage infestation of workers and soldiers, their damage and impact on the yield. The maximum mean populations of *O. obesus* workers were recorded on 2KCGC20 (30.82±2.75 workers/plot) and Australian (30.65±2.92 workers/plot), followed by BARI 2000 (19.55±2.51 workers/plot), Golden (17.30±2.27 workers/plot) and BARD-479 (16.82±2.06 workers/plot). The minimum mean population of *O. obesus* workers was found on ICG-7326 cultivars (14.85±1.81) workers/plot. The maximum mean population infestation of *O. obesus* soldiers was recorded on 2KCGC20 cultivar (4.88±0.25 soldiers/plot) followed by Australian (4.15±.30, soldiers/per plot), BARD-479 (2.00±.17 soldiers/plot), ICG-7326 (1.70±.14 soldiers/plot), BARD 2000 (2.40±.25 soldiers/ plot). The minimum mean population of *O. obesus* soldiers was found on Gold (1.87±.17 soldiers/plot). Population of *O. obesus* workers was positively related with the damage and negatively related the yield in all the groundnut cultivars.

Introduction

Groundnut (*Arachis hypogea* L.) belongs to family Fabaceae, is an important oil seed crop that contributes a major role in economy around the world (FAO, 2006; Narada et al., 2003; Nwokolo, 1996; Wiess, 2000). In Pakistan, this crop is considered as cash oilseed crop in the rain fed regions of Punjab (Hussain and Ahmed, 1984). It is the 3rd most important source of vegetable protein and contains 50 percent edible oil, 28 percent digestible protein and 20 percent carbohydrates (Bhatti and Soomro, 1996; Christensen et al., 2004; Shah et al., 2012). It is a dietary source of vitamin E, phosphorus, Mg, Ca, Zn, Fe, thiamine riboflavin, and potassium and also used as diet of animals in the form of seeds, fodder, hay and straw (Smith, 2012). Groundnut is cultivated in tropical, subtropical and warm temperature climates (Carley and Fletcher, 1995). In Pakistan, more than 90 percent of the groundnut cultivated area is in the province of Punjab, of which approximately 87 percent area under cultivation is in Rawalpindi, Jhelum and Attock districts (Ahmed and Rahim, 2007; Hatam and Abbasi, 1994; Khan et al., 2009; Naeem-ud-din et al., 2009).

Despite of being an important oil seed crop, its per acre yield is still low in Pakistan due to unavailability of high yielding varieties, unprecedented environmental conditions, less rainfall and low inputs by the farmer (Khan et al., 1993). It is actually a stifling plant and requires an extended and hot growing period with optimum temperature (25 to 30ºC) and optimum rainfall (500 mm) (Weiss, 2000). A well-drained sandy loam soils (pH 6.0-6.5) best thrive for groundnut (Basu and Ghosh, 1995).

Several factors are responsible for economic losses to groundnut crop such as variable rainfall, low soil fertility, crop management practices, pests and diseases (Naab et al., 2004). Several insect pests attack the groundnut crop that may cause moderate to severe damage (Javed et al., 2014). Among groundnut producing countries of Asia (including Pakistan) the major insect pest of groundnut include leaf miner, white grub, jassid, aphid, thrips, red hairy caterpillars and termites (Salihah et al., 1988; Sheirdil et al., 2012). Soil insect pests cause serious economic losses to groundnut crop (Wightman et al., 1990).

Termites *O. obesus* (Rambur) are social insects, attack on the tap root, feed out all contents ultimately replacing

it with mud (Rawat et al., 1970). In case of sever attack, termite can cause 5 to 45 percent mortality of plants and 46 percent damages to pod (Kaushal and Deshpandy, 1967; Painter, 1951; Roonwal, 1981; Salihah et al., 1988). Different control methods such as cultural practices, biological control and application of plant extracts and insecticides are used to control termites (Ahmed and Nasir, 2008). The absolute reliance on chemical measures to manage the pests has created pesticides resistance and hazards to human and animal life and also increased the environment pollution around the world (Afzal, 2014; Bakhsh, 2009; Gold et al., 1996; Soerjani, 1998).

The use of termite resistant approved groundnut genotypes can be a very important dimension of integrated pest management (Painter, 1951). The major objective is to bridge the yield gap, ultimately making the groundnut as a profitable crop under rain fed conditions (Khan et al., 2009).

The Identification of termite resistant and high yielding varieties through screening can provide a convenient way for farmers to grow termite resistant groundnut cultivars for better yield. This ultimately will help to reduce the excessive use of insecticides on the crop leading to reduce the hazards to human and animal health and environmental pollution around the world (Soerjani, 1998). Host plant resistance (HPR) is a major constituent of integrated pest management (IPM) program that protects the crops by making it less susceptible for pest. Although, various successful attempts has been made for screening groundnut cultivars against termites with IPM techniques by Amin and Mohammad, (1982); Amin et al. (1985); Mohapatra et al. (1995) but resistance studies related to pod scarifying termites has yet not been reported so far in Pakistan. Therefore, keeping in view the potential threat of *O. obesus* to groundnut, the present study was conducted to evaluate some commercially grown groundnut cultivars against populations of *O. obesus* and resultant damage and yield losses.

Material and Methods

Experimental Design and Plant Material

The study was conducted at University Research Farm, PMAS-Arid Agriculture University, Rawalpindi, Pakistan. Six test groundnut varieties (Golden, BARI-2000, Icg-7326, BARD-479, Australian, and 2KCGC20) were sown in a Randomized Complete Block Design (RCBD) with four replications during April, 2010. Seeds of (Golden, BARI-2000, ICG-7326) cultivars were obtained from Barani Agriculture Research Institute (BARI), Chakwal, Pakistan while seeds of (BARD-479, Australian, and 2KCGC20) cultivars were obtained from National Agriculture Research Centre (NARC), Islamabad, Pakistan. Seed rate was kept 80 kg ha^{-1}. The plot size was kept 4 x 4.5 m^2 for each replication with border size of 1m, respectively. Each plot comprised 10 rows of 3.6 m each and plant to plant and row to row distances were kept at 25 and 45 cm, respectively. All agronomic practices (weeding, fertilizer application and irrigation) were strictly followed and no chemical measures were applied throughout the crop season to avoid any ill effect on population density of *O. obesus*.

Detection for O. obesus population

For the detection of *O. obesus* population (works and soldiers) in the experimental fields, four wood stacks (wrapped with blotting paper and tightened with rubber bands) of poplar (*Populus fastigiata*) tree were inserted vertically 25 cm deep into soil in each experimental plot and observed after a week interval to confirm the presence of termites in each tested plot. After confirming the presence of termites in all the tested plots, wooden stakes were replaced with NIFA-TERMAPS® traps.

Sampling for O. obesus population

Sampling for termite's population was done by using NIFA-TERMAPS® traps by developed trapping techniques (Salihah et al, 1988). For this purpose, traps were installed in each experimental plot. The trap comprised of a piece of plastic pipe (15 cm diameter and 30 cm length) having inside the four pieces of (*P. fastigiata)* wood of 16×8 cm size (wrapped with blotting paper and tightened with rubber bands). For installation of traps, a hole of 30 cm depth and 20 cm diameter was made and position of trap pipe was kept approximately 5 cm above the soil surface. The observation was made 10 days after installation of traps. The observations were taken until 135 days after sowing (DAS) with 10 days interval.

Level of susceptibility/receptivity

Observation for number of workers and soldiers for each variety was recorded according to started 55 and 45 respectively, days after sowing (DAS) through visual observation and continued with 10 days of intervals. The level of susceptibility/receptivity of these varieties towards termites was estimated on the basis of infestation level per plot. Percentage infestation in plots of each cultivar was calculated according to the following formula:

$$\% \text{ Infestation} = \frac{\text{Number of infested traps per plot per variety}}{\text{Total number of observed traps plot per variety}} x100$$

Statistical Analysis

The experimental data was analyzed using computer software 'MSTATC' and means were compared by the Least Significant Difference at 0.05% of probability (Steel et al,. 1990).

Results and Discussions

Trend of O. obesus workers population

There was a significant difference in populations of *O. obesus* workers among all groundnut cultivars at all observation dates (Table 1). Golden cultivar was moderately resistant among all the tested cultivars having the minimum mean *O. obesus* workers population (17.30±2.27 individuals), while 2KCGC20 cultivar was highly susceptible with the maximum population

(14.85±1.81 individuals) throughout the duration of the crop. The descending order of *O. obesus* workers' population in different groundnut cultivars was: Gold, BARD 2000, ICG-7326, BARD 479, Australian and 2KCGC20 respectively.

Observation for *O. obesus* workers population was started at (55 DAS). The population started to increase during (65-75 DAS). The highest population was recorded at (105 DAS). The maximum population (67.00 workers/plot) was recorded on 2KCGC20 cultivar; statistically similar with Australian cultivar (66.00 workers/plot). The minimum population (49.75workers/plot) was recorded on Golden cultivar. The population infestation started to decrease gradually after (115 DAS). The minimum mean population infestation was recorded at 135 DAS on all tested groundnut cultivars (Table 1).

Trend of O. obesus soldiers population

There was a significant difference in populations of *O. obesus* soldiers among all groundnut cultivars at all observation dates (Table 2). It was observed that Golden cultivar was comparatively resistant among all six tested cultivars having the minimum infestation of soldiers (Average=1.87±0.17), while 2KCGC cultivar was highly susceptible with the maximum (4.88±0.25) mean soldiers infestation. The observations were taken until 135 days after sowing (DAS) with 10 days interval. The descending order of soldier population in groundnut cultivars was Gold, BARD 2000, ICG-7326, BARD 479, Australian and 2KCGC20 respectively.

Observation for soldiers' population was started 45 DAS. The population infestation of soldiers started to increase steadily during 65 to 75 DAS. The highest mean population of soldiers (7.50 soldiers/plot) was on Australian cultivar, statistically similar with 2KCGC cultivar (7.20 soldiers/plot) while the lowest mean population (4.50 soldiers/plot) was found on Golden cultivar at 105 DAS. The population infestation of soldiers started to decline 115 DAS. The minimum infestation of soldiers was recorded at 135 DAS on all tested groundnut cultivars (Table 2).

The correlation among populations of *O. obesus* workers and damage on different groundnut cultivar is shown in (Table 3). There was significant ($P<0.01$) and positive correlation among populations of *O. obesus* workers and damage to all tested groundnut cultivars *i.e.* Golden (0.96), ICG-7326 (0.95), BARI-2000 (0.93), 2KCGC20 (0.89) BRAD-479 (0.88) Australian (0.74). These findings were in confirmation with Amin et al. (1985) that termite resistant groundnut verities expressed lower damage. Bhanot et al. (2009) reported positive correlation among *O. obesus* workers and damage in barley crop.

Table 1 Comparison of average *O. obesus* workers population at various intervals among groundnut cultivar

Groundnut	Mean *O. obesus* workers population (DAS)								
Cultivars	55	65	75	85	95	105	115	125	135
2Kcgc 20	3.75 a	23.00 a	22.75 a	33.25 a	43.75 a	67.00 a	44.25 a	18.75 a	31.0 a
Australian	3.25 a	20.50 a	22.00 a	36.25 a	46.50 a	66.00 a	45.75 a	17.25 a	33.75 a
Bard-479	2.25 b	8.00 b	9.25 b	19.00 b	23.75 c	45.50 cd	24.25 a	12.25 b	16.75 bc
Icg-7326	1.75 b	8.25 b	7.25 b	14.75 c	22.25 c	10.75 d	23.00 c	9.00 c	14.25 c
Bari 2000	1.75 b	6.75 b	9.50 b	21.50 b	32.75 b	53.75 b	32.50 b	11.75 bc	21.00 b
Golden	1.00 c	6.00 b	9.50 b	18.75 b	28.50 bc	49.75 bc	28.75 bc	1.25 bc	16.25 c
LSD at 0.05	0.70	2.55	2.92	3.74	6.44	8.93	5.92	3.01	4.7
Frequency	19.33	80.05	52.47	49.29	22.35	13.58	25.05	14.38	27.99

*Mean values followed by the different letter in the same column are statistically different ($P\leq0.05$, D.F=15)

Table 2 Comparison of average *O. obesus* soldiers population at various intervals among groundnut cultivar

Cultivar	Mean *O. obesus* soliders population (DAS)									
	45	55	65	75	85	95	105	115	125	135
2Kcgc 20	3.00 a	4.50 a	4.50 a	5.50 a	5.25 a	7.00 a	7.20 a	5.25 a	2.75 a	3.75 a
Australian	1.75 b	2.00 b	2.00 b	4.75 a	4.75 a	6.75 a	7.50 a	4.50 a	2.50 a	2.75 b
Brad-479	1.00 c	1.00 c	1.00 c	1.25 c	2.50 b	3.00 bc	4.50 bc	1.75 b	1.00 b	2.25 bc
Icg-7326	1.00 c	1.00 c	1.00 c	1.25 c	2.00 b	2.25 c	3.70 c	2.00 b	1.00 b	1.75 c
Bari 2000	1.00 c	1.25 b	1.25 b	2.25 b	2.75 b	4.00 b	5.70 a	2.25 b	1.25 b	2.00 c
Golden	1.00 c	1.00 c	1.00 c	1.25 c	2.00 b	7.00 a	4.50 a	2.50 b	1.00 b	1.75 c
LSD at 0.05	0.30	0.44	0.69	0.80	0.88	1.32	1.46	0.85	0.50	0.70
F-value	63.40	88.74	45.32	51.87	51.87	23.14	10.35	26.74	33.00	10.82

*Mean values followed by the different letter in the same column are statistically different ($P\leq0.05$, D.F=15)

Table 3 Correlation among populations of *O. obesus* workers, damage and yield on tested cultivars.

Cultivars	Correlation among populations of O. obesus workers and damage on groundnut cultivars		Correlation among populations of O. obesus workers and yield of groundnut cultivars
Golden	0.96		-0.83
Bari-2000	0.93		-0.96
Australian	0.74	Significant	-0.79
Brad-479	0.88	at P≤0.001	-0.89
Icg-7326	0.95		-0.72
2 kcgc 20	0.89		-0.95

The correlation among populations of *O. obesus* worker and impact on yield of targeted groundnut cultivar is shown in Table (3). There was a significant (P<0.01) and negative correlation among populations of *O. obesus* workers and their impact on the yield of all test ground cultivars *i.e.* BARI-2000 (-0.96), 2KCGC20 (-0.95), BRAD-479 (-0.89), Golden (-0.83), Australian (-0.79) and ICG-7326 (-0.72). These finding were confirmatory with Mohapatra et al. (1995) who screened 23 groundnut varieties, four varieties were resistant to termites while other tested varieties were less susceptible to termite attack but simultaneously gave high yield of groundnut pod under field conditions. Our studies results related to *O. obesus* worker and soldiers are in agreement with the results of (Ijaz and Aslam, 2003) who reported that difference in mean infestation of *O. Obesus* may be due to crop vigorous. Preference and non-preference of *O. Obesus* might be due to chemical nature of plant wood, level of moisture content, concentration of cellulose and lignin in plant primarily due to the fact that termites prefer to attack on plants having high concentrations of cellulose (Judd and Corbin, 2009; McMahan, 1966). Further, fluctuations of termite's population might be due to influence of abiotic factors. The above findings are in accordance with the Al-Hemyari (1994) who reported that rise and fall in temperature may influence on the foraging activity of termites. However rain fall can induce a suitable temperature and humidity for termites foraging activity as reported by Akhter and Amanullah (1989).

Conclusion

The Australian and 2KCGC-20 were found to be comparatively more susceptible cultivars due to maximum *O. obesus* infestation while ICG-7326 and Golden cultivars seemed to be less susceptible due to minimum infestation. Based on our results finding, ICG-7326 and Golden cultivars can be recommended as comparatively resistant to termites attack for the farmers of Pothwar region of Pakistan.

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