Current Status of Wheat Bunt Disease in Iraq

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Abstract: Common bunt of wheat is one of the most important diseases of wheat in Al-Jezera and northern parts of Iraq. Yield losses up to 70% were recorded in most wheat fields sown with untreated seeds. Recently an epidemic form of the disease was observed in the central and southern parts of Iraq for the first time. High disease incidence was detected in most wheat fields in the region. This caused potential hazard to wheat production in the country. A systematic survey was conducted to detect the importance and geographical distribution of the disease in Iraq and to identify the causal agents. Results revealed that the disease is distributed in most of wheat fields in the northern and central parts of the country. The high level of wheat grain contamination with bunt balls was about 1.3% (w/w) in Diyala province and the low percent was about 0.04% (w/w) in Wasit. The disease was also detected for the first time in two locations in the south. These levels of contamination caused 50–100% superficial contamination of wheat seeds with teliospores of the causal agents in all wheat samples. *Tilletia tritici, T. laevis, T. intermedia* and *Tilletia* sp. were identified in all infected samples collected from wheat fields. The frequency of *T. tritici* was high (38.4%) in the north, while both *T. laevis* and *T. intermedia* were more frequent in the south (34.5 and 8.9%, respectively) followed by *Tilletia* sp. (25.5%) in the middle zones.

Keywords: covered smut; *Tilletia tritici; Tilletia laevis; Triticum aestivum;* common bunt

Bread wheat *Triticum aestivum* L. is one of the most important cereal crops in terms of cultivated area and economic importance in Iraq. The total cultivated area of wheat is about 1.5 million hectares distributed on different agro ecological zones or Mega environments (FAO 1999). The annual production of wheat in the country is limited and fluctuated due to many stresses. Fungal diseases are the most important biotic constraints of wheat. Several diseases particularly rust and smuts have drastically decreased grain yield and quality of wheat. Among the smuts, common bunt incited by *Tilletia tritici* and *T. laevis* is the most important disease. Occurrence and distribution of the disease was limited in Al-Jezireh and northern parts of Iraq. Yield losses up to 70% were recorded in most wheat fields sowed with untreated seeds (Al-Baldawi 1993; Al-Maaroof *et al.* 1995).

Chemical seed treatment is regularly used to control wheat bunt disease in Iraq. By law it is not allowed to sow untreated seeds particularly in the north. Organic mercury compounds were widely used in the past to control wheat bunt in Iraq.

Historically many poisoning problems were reported due to the direct or indirect consumption of treated seeds by farmers. Application of ethyl mercury (Cerasan) was the principle cause of human and livestock poisoning in 1956 and 1960, while seed treatment with methyl mercury compounds (Panogen and Methyl Mercury Acetate) caused severe poisoning in 1972, where 459 people died and other 6530 were poisoned (Baker 1973). Later Diathane M-45 was widely used in Iraq to protect wheat infection from bunt disease when it was reported to be very effective in the disease control by plant pathology department at Iraqi ministry of Agriculture (Daoud & Al-Hassan 1981). Other previous studies results confirmed efficacy of some other chemical compounds and fungicides in controlling the disease in addition to Diathane M-45 (Al-Baldawi *et al.* 1981; Daoud & Al-Hassan 1981; Hassan & Mustafa 1981). While Al-Maaroof *et al.* (2004) indicates the high efficiency of the fungicides, Mancozeb S-80, Diathane S-60 and Dividend 30 WS in wheat protection from bunt diseases under Iraqi environment conditions (Al-Maaroof *et al.* 2004).

Recently the disease was observed for the first time in the central and southern parts of Iraq. High disease incidences were detected in most wheat fields in the region during 2001/2002 season, which causes potential hazard to wheat production in the country (Al-Maaroof *et al.* 2005).

Therefore, there is an urgent need to search for the distribution of wheat bunt diseases in all wheat growing area in the country. Furthermore, to use all the technological possibilities to control bunt disease resistance and improve grain quality of wheat.

MATERIAL AND METHODS

A systematic survey was conducted during 2002/2003 season to detect the importance and geographical distribution of wheat bunt disease in different agroecological zones of Iraq. The survey included six locations in Nineva and Salahuddin representing north parts of Iraq. Eight locations in Baghdad, Diyala and Wasit representing the middle zones and two locations in Dequar and Qadesia representing south of Iraq. Wheat samples (2 kg for each sample) were collected directly from farmer seed lots. Each sample was tagged with the location and farmers names and transferred to the laboratory for further tests. 250 g seed from each sample was used to determine percentage of seed contamination with bunt balls. Number and weight of bunt balls in each sample was counted in accordance to Codex Alimentarious Commission (annex A), (FAO 1989). Number of teliospores from each grain was determined by Heamocytometer. Each bunt ball was crashed in a mortar, purified by sieving with 500 micrometer. 100 ml of distilled water was added to each sample and mixed. One drop was used on Hemocytometer to calculate number of teliospores in each ml of water then multiplied by 100 which is equivalent to number of teliospores in each grain. Ten bunt balls were used from each sample. Inoculums load for each sample was determined in accordance to participation method described by Neergaard (1977). Ten milliliter of sterilized distilled water was added to one gram of superficially contaminated seed with teliospores in 100 ml flask. The samples were mechanically mixed for ten minutes and the suspension was centrifuged for 15 min at 2000 rpm/min. One milliliter of sterilized distilled water was added to the precipitate and mixed with glass rod. One drop of the supernatant was used to determine number of teliospores in each millimeter which is equivalent to the inoculums load of each gram of wheat grain.

Seeds of two bread wheat cultivars were artificially inoculated with a bulk population of *T. tritici*, *T. laevis* and *T. intermedia* teliospores collected from different locations of Iraq in previous season at a rate of 0.5 g/100 g seeds. Inoculated seeds were mechanically mixed for 15 min by shaker at 80 rpm/min (Doddof & Todorova 1974): then treated with different fungicides and organic compounds according to the recommended doses as follows:

Carboxine75 WP (5, 6-dihydro-2-methyl 1-4-oxathilin 3-carboxyanilide) (Anilide or Oxanithin) at the rate of 2 g/kg of wheat seeds.

Raxil DS (1-chlorophenoxy 4,4-dimethyl-3-(1H-1, 2,4-triazole-1-3methyl) pentane at the rate of 1.5 g/kg of wheat seeds.

Vitanis plus WP [(Carboxin 37.5% + Thiram 37.5%) (Difenocoazole)] at the rate of 1 g/kg of wheat seeds.

Dividend 30 WS (Difenocoazole) at the rate of 1 g/kg of wheat seeds.

Chemofoam (Sulfur foam) at the rate of 8 g/kg of wheat seeds.

Skim – milk powder at the rate of 45 g/kg of wheat seeds.

Bread wheat flour at the rate of 45 g/kg of wheat seeds.

Control seeds were left with out any chemical treatment. Treated seeds were uniformly mixed in polyethylene sac. The experiment was conducted under Latifia Experimental station, 45 km south of Baghdad. Plots were arranged in a Randomized Complete Block Design with three replicates. In order to secure high levels of infection under Latefia environmental conditions, contaminated and treated seeds were grown on two meter rows and 30 cm apart by the end of November at 7–9 cm depth. They were irrigated 3–4 days before cultivation. First irrigation was given at the appearance of the first true leaf in 50% of the seedlings. At dough stage, disease incidence was calculated by counting number of healthy and infected spike per each meter. Data was statistically analyzed.

RESULTS AND DISCUSSION

Table 1 shows incidence of wheat bunt disease in different wheat growing areas of Iraq. The highest level of wheat grain contamination with bunt balls of common bunt disease 1.3% (w/w) which was equivalent to 2.5% as number/number was detected in Diyala province/Baladruz representing middle zones of Iraq, while the lowest level of contamination was detected in Wasit/Hey in the same location. In general wheat bunt incidence was more frequent in the northern part of Iraq during 2003. The total mean of seed lot contamination with bunt balls was 0.66% mass/mass in the north followed by 0.33% contamination as mass/mass in the middle zone and 0.09% in the south.

It is quite clear that levels of seed contamination with bunt balls in most of wheat lots in north and middle parts of Iraq were higher than the international standard limits which allows only 0.1–0.5% contamination in seed lots (FAO/WHO 1989). The high levels of contamination with bunt balls caused 50–100% superficial contamination of healthy wheat seeds with different *Tilletia* species teliospores. This was due to the high contents of each bunt ball with teliospores which was ranged from 11–70 million teliospores/bunt ball according to seed size, shape and teliospores dimensions.

Results also revealed that the high inoculums load of healthy seeds 2.7 × 10^6 spore/g seed was detected in Diyala/Baladruz while the lowest one was detected in Wasit/Kut (Table 1). It seems also inoculums load levels of some seed lots are not compatible with the levels of contamination with bunt balls in each seed sample. This variation may

Table 1. Percentage of wheat seeds contamination with bunt balls of common bunt disease during 2003 season in different locations of Iraq

Location	Highest percent of seed contamination with bunt ball		% of superficial contamination of seeds with teliospores	Inoculums load spore/g seeds	No. of teliospores/ bunt ball "Millions"
	(w/w)	(No./No.)			
Nineva/Mosul	1.00	1.60	100	1.00 × 10^6	60
Nineva/Sinjar	1.00	1.50	100	0.70 × 10^6	30
Nineva/Rabia	0.50	1.20	100	0.14 × 10^6	40
Nineva/Telafr	0.50	1.00	100	0.80 × 10^6	30
Nineva/Hamdania	0.70	0.90	100	1.80 × 10^6	60
Nineva/Sherqat	0.10	0.20	100	0.07 × 10^6	30
Salahedin/Tekrit	0.90	1.50	100	2.00 × 10^6	40
Salahedin/Balad	0.60	1.40	100	1.30 × 10^6	70
Baghdad/Tarmia	0.06	0.20	50	0.06 × 10^6	20
Baghdad/Ishaqi	0.50	1.50	100	0.20 × 10^6	27
Diyala/Bledruz	1.30	2.50	100	2.70 × 10^6	50
Diyala/Mandeli	0.30	0.90	100	0.46 × 10^6	20
Diyala/Mqdadia	0.20	0.80	100	0.13 × 10^6	11
Diyala/Kaneqin	0.20	0.70	100	0.08 × 10^6	20
Wasit/Kut	0.07	0.08	50	0.02 × 10^6	40
Wasit/Hey	0.04	0.05	50	0.03 × 10^6	40
Deqar/Shatra	0.06	0.07	50	0.06 × 10^6	60
Qadsia/Mhenawia	0.08	0.10	75	0.03 × 10^6	30
Mean	0.52	0.90	87.5	0.63 × 10^6	37.6

occur due to the moisture content of bunt balls. High moisture contents in each bunt ball causes accumulation of teliospores in masses which inhibits its distribution and superficial contamination of healthy seeds according to the original levels of contamination in seed lots. Furthermore, it is also correlated with the morphological characteristic of seeds in each cultivar. High inoculums load can be detected in wheat cultivars which contain a lot of long brushy hair in seed top. Therefore, selection of smooth seeds (hairless) will be with high value in breeding program for resistance to common bunt disease in wheat (Heyne 1987).

Table 2 data's indicate distribution and frequency of *Tilletia* species in different infected wheat fields of Iraq. *Tilletia tritici* is more frequent in the north (38.4%) followed by *T. intermedia* (21.0%), *T. laevis* (20.6%) and *T.* sp. (20.0%) subsequently. High frequency of *T. leavis* (34.5%) and *T. tritici* (26.5%) were detected in south of Iraq followed by *T. intermedia* (24.0%) and *T.* sp (15.0%). Distribution of *T.* sp. was more frequent in the middle zone of Iraq (25.5%). Occurrence and distribution of *T. tritici* in the north will fit with the low temperature requirement of the species as mentioned in the earlier studies (Faris 1974). Detection of the natural hybrid between *T. tritici* and *T. laevis* confirms the earlier report of Ibrahim *et al*. (1988), which mentions existence of *T. intermedia* in the north parts of Iraq. Meanwhile, detection of *T.* sp. in the middle zones was reported previously by Al-Maaroof *et al*. (2005).

It is clear and undoubted that common bunt disease moved from wheat growing area in the north to the middle zones through its way to the south. In comparing with the previous studies (Al-Maaroof *et al.* 2005), it is quite clear that the disease was well established during 2003 in most wheat fields in Baghdad, Diyala, Wasit representing middle zone of Iraq, in contrast to the earlier studies which reports restriction of wheat bunt disease occurrence in north parts of Iraq only (Al-Adami 1953; Al-Baldawi *et al.* 1983; Al-Maaroof *et al.* 1995). This is the first report which indicates movement of wheat bunt disease to the south during 2003 and detection of the disease in two provinces Dequar and Qadsia. Disease movement from its origin in the north to middle and south parts of Iraq probably attributed to cultivation of contaminated wheat seeds in most wheat fields in these areas particularly in wheat/rice cropping system which provide adequate environmental condition for teliospores germination and development of the disease (Saleh 2002). However appearance of new physiological races of *Tilletia* spp. and its adapting to the prevalent environmental conditions in the middle and south parts of Iraq could be one of the principle causes of disease occurrence in this area. Since a dense breeding program was conducted in this area to induce resistance against common bunt disease using different techniques (Ibrahim *et al.* 1988a, b; Ibrahim *et al.* 1993; Al-Maaroof *et al.* 1995). The wide application of non certificated fungicides from unknown resources by some wheat growers or private companies for seed treatment during embargo period in Iraq could be one of the main causes of bunt disease establishment on wheat in this region. Furthermore, the continuous and widespread uses of the high effective fungicides on large area have also developed resistance appearance in the causal agent population against the fungicides (Agrios 1997). In Australia and Greece, strains of *T. laevis* has developed resistance against polychlorobenzen fungicides (Weise 1987).

Results in Table 3 show that there are significant differences in the efficiency of the applied fungicides and organic compounds on disease control of wheat bunt in comparing with disease incidence of control treatment, which was 62.63% in SaberBeg and 56.93% in Sally. Dividend 30WS

Table 2. Percentage of *Tilletia* species frequencies in infected wheat fields in different locations of Iraq

Fungus	Distribution and frequency (%)		
	north	center	south
Tilletia tritici	38.4	25.4	26.5
Tilletia leavis	20.6	28.9	34.5
Tilletia intermedia	21.0	20.2	24.0
Tilletia sp.	20.0	25.5	15.0

Table 3. Efficiency of some fungicides and organic compounds on wheat bunt disease control at Latifia Experimental Station, Baghdad, Iraq

Treatment	Rate of use (g/kg seed)	Infection (%)*	
		SaberBeg	Sally
Carboxin 75 WP (5,6-dihydro-2-methyl 1-1-4 oxathilin-3-carboxanilide)	2.0	1.13	1.63
Dividend 30 WS (Difenocoazole)	1.0	0.00	0.00
Chemofoam (sulfur foam)	8.0	12.35	22.26
Raxil DS (1-chlorophenoxy 4,4dimethyl-3-(1-H-1,2,4-triazole-1-3-methyl) pentane	1.5	1.06	0.00
Vitanis plus WP [(Carboxin 37.5% + Thiram 37.5%) (Difenocoazole)]	1.0	2.10	0.00
Skim – milk powder	45	9.80	14.80
Bread wheat flour	45	7.33	5.23
Control	0.0	62.63	56.93
$LSD_{0.05}$		5.83	5.83

*each number represent the mean of three replicates

had proved complete control on bunt disease (100%) in both cultivars. Meanwhile, Carboxin, Raxil and Vitanis plus were highly effective in bunt disease reduction by 96.2–100% in the susceptible cultivar "SaberBeg" and 97.3–100% in the moderately susceptible cultivar "Sally". Treatment with skim milk powder and bread wheat flour gives adequate protection from the disease by 84–88% and 74–91% in SaberBeg and Sally respectively under Iraqi environment conditions. While seed treatment by chemofoam did not secure adequate protection from the disease at the rate of 8 g/kg seeds, although it is earlier reported that the biproduct of Iraqi industries "sulfur foam" could be very effective in common bunt disease control (Hassan & Mustafa 1981; Hassan *et al.* 2001). Efficiency of organic matter "skim milk powder and bread wheat flour" in bunt disease control probably attributed to the activity of soil micro organisms which utilize these compounds as food resources and inhibit growth of the causal agents and compete other microorganisms in the soil (Borgen & Kristen 2001).

The current study results encourages application of Dividend and Carboxin to control bunt disease particularly in high grade seed production fields. It also can be concluded that combination of organic matter with the available biocontrol agents will improve the strategy of common bunt disease control under Iraqi environmental conditions particularly in the organic agriculture. In conclusion, there are urgent needs to use all the technological possibilities to control bunt disease resistance and improve grain quality of wheat.

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