Plant Damages and Yields of the Different Rice Cultivars to Brown Planthopper (*Nilaparvata lugens* S.) in Fields

Y.H. KIM[1], J.O. LEE[1], H.C. PARK[2], AND M.S. KIM[1]

金容憲・李正云・朴熙喆・金萬壽 : 벼멸구에 의한 벼品種의 被害와 收量

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ABSTRACT Plant damages and yields of the different rice cultivars to brown planthopper (BPH), *Nilaparvata lugens* S., were observed for the evaluation of varietal resistance in paddy fields. Twenty nine Korean cultivas were transplanted in paddy fields with three plots of no insecticide, no insecticide and fungicide, and no fungicide at Haenam, southern coastal area in 1983. Among 6 varieties with BPH resistant genes, Samgang, Gaya, Hangangchal, and Cheong-cheong showed very low populations of BPH and no damages on all treatments. Milyang 30 and Wonpung among them had considerable populations of BPH. Seokwang and 23 others showed high populations and serious damages. Yield increasea(%) with insecticides were low on Gaya (12%), Samgang(29%) and Hangangchal(35%), but very high on Bongkwang(260%), Palgueum (223%), Songjeon(200%), and Guanauk(200%).

The brown planthopper(BPH), *Nilaparavata lugens* (Stal) has become an important pest of rice in Asian countries including Korea in recent years. The population of BPH builds up on rice plants by passing through two to three generations after migration from southern China from June to July every year. High temperature and large amount of immigrant BPH cause hopperburning. Population levels can also differ depending on host plant characters including resistance as well as temperature and number of immigrant BPH.

Samgang, Gaya, Hangangchal, Milyang 30, Cheong-cheong, Wonpung and 3 others among about 40 leading cultivars, with high yield potentiality and resistance to the brown planthopper, have been released for commercial cultivation in Korea (Kim 1983). Population and plant damages may be different on the maturity of variety. The severity of damage was in the order of[1)] initial tillering,[2)] initial booting,[3)] maximum booting,[4)] milky,[5)] maximum tillerring, and[6)] doughty stage (Cheong 1979).

The relationships of insect population, damage and yield were found on 29 leading varieties in this experiment for supporting information on the determination of economic threshold to BPH.

1 Department of Entomology, Institute of Agricultural Sciences, Suweon, Korea(農業技術硏究所 昆虫科)
2 Jeon-nam Provincial Rural Development Administration Kwangju, Korea(全南農村振興院)

MATERIALS AND METHOD

The experiments were designed to obtain information on the effects of resistant varieties to brown planthopper. Field studies were carried out on paddy fields of Haenam brench, of Jeonnam Provincial Rural Development Administration, Haenam, Jeonnam, in 1983. Twenty nine Korean leading cultivars of thirty five days old seedlings were transplanted at a spacing of 27×15cm, 3 seedlings per hill, 40 hill per row, and 3 rows per variety on June 1, 1983. The cultivars tested were grouped to hybred race (Indica×Japonica) and Japonica race. They were transplanted into hybred race and Japonica race separately. The above mentioned varieties were Samgang, Gaya, Hangangchal, Seokwang, Milyang 30, Baegyang, Milyang 23, Milyang 42, Sinkwang, Sinsunchal, Cheongcheong, Wonpung, and Pungsan. The latter were Daechang, Sangpung, Nongbaeg, Dongjin, Seonam, Bogkwang, Odae, Seolauk, Nagdong, Seomjin, Guanauk, Bongkwang, Palguem, Chucheong, Sobaeg, and Songjeon.

Before transplanting, fertilizer was incorporated into the paddy soil at the rate of 75 kg N, 90 kg of P, and 77 kg of K per ha. Additional application of 30 kg of N and 45 kg of N and 33 kg of K were broadcasted at 15 and 55 days after transplanting (DAT) respectively. The plots had no insecticide (applied only fungicides), no insecticide and fungicide, no fungicide (applied only insecticide). The no insocticide plot was treated with 3.6 kg ai/ha Isoran G. at 21 DAT, 0.06 kg ai/ha Neozin-Lq. and 2.4 kg ai/ha Benasol G. at 56 DAT, and 0.042kg ai/ha Hinosan Ec. at 80 DAT. The no fungicide plot was treated with 0.9 kg ai/ha Carbofuran G. at 21 DAT, 0.7 kg ai/ha Cartap Sp. and 0.9 kg ai/ha Carbofuran G. at 56 DAT, 1.2 kg ai/ha Carbofuran G. at 81 DAT, 0.8 kg ai/ha BPMC D. at 82 DAT, and 0.8 kg ai/ha BPMC Ec. at 94 DAT.

The number of BPH nymphs and adults were observed on 30 hills in the no insecticide and no insecticide and fungicide plot on August 18 (79 DAT). The next observation of BPH populations was conducted only in the no insecticide plot on September 2. The first measurement represents the first dead plants and the second measurement the total dead plants. Yields per variety were measured from the rough grains of all planting hills. The yield increase (%) due to insecticide was calculated by dividing the yield of the insecticide plot by the no insecticide plot. The yield increase (%) due to fungicide was calculated by dividing the fungicide plot by the no fungicide plot.

RESULT AND DISCUSSION

There were significantly different brown planthopper (BPH) populations on the different rice cultivars. Samgang, Gaya and Cheongcheong showed very low population of BPH and no damage on all treatments of no insecticide application (NIA), no insect-fungicide application (NIFA), and no fungicide application (NFA). Resistant causes of those varieties were considered to originate from resistant genes to BPH. Cheongcheong crossed with IR 2035 in which the parents originated from Mudgo with Bph 1 gene. Hangangchal crossed with IR 2061 originated from IR 26 with Bph 1 gene. Samgang crossed with Milyang 30 which was reported to have from Bph 1 gene to BPH by Jun et al(1978). The parent of Gaya includes Milyang 30 with Bph 1 gene and IR 32 with bph 2 gene. One dominant (Bph 1) and one recessive gene (bph 2) have been indentified for resistance to brown planthopper (Athwal and Path ak 1972). On the other hand, though both Milyang 30 and Wonpung had resistant genes, they had considerable population of BPH. Brown planthoppers increased to 56 insects per hill in the no insecticide plot, and 101 insects per hill in the no insecticide and fungicide plot on the Milyang 30 on 18th August. Population of BPH on Milyang 30 was not increased on September 2. However, Wonpung had 40 insects per hill in the NIA plot, 201 insects per hill in the NIFA plot on August 18, and insect populations increased to 76 insects per hill in the NIA plot and 885 insects per hill in the NIFA plot on September 2. It is uncertain why Milyang 30 and Wonpung with resistant gene had high population of BPH in this experiment. Lee and et al. (1978) reported that Milyang 30 had very low population of BPH in 1978. BPH may have developed its feeding activity to increase its population on Milyang 30. The data does not explain why Milyang 30 and Wonpung with Bph 1 gene as well as Samgang, Hangangchal and Cheongcheong had high populations on the susceptible cultivars.

Seokwang and 23 other cultivars showed high population and serious damages. They were also susceptible to BPH in the seedling bulk test (Kim, 1983). There are some differences in the populations of BPH among susceptible cultivars. In the no insecticide plot, the populations of BPH had at least 39 insects per hill on Milyang 23 and the highest 677 insects per hill on Bongkwang in the 18th August observation and at least 20 insects per hill on Sobaeg and the highest 640 on Palguem in the second September observation. Before observation, some varieties including Bogkwang, Sobaeg, and Songjeon were hopperburned, they had high population in the first observation, but very low population in the second observation (Sep. 2). On contrary, most cultivars in no insecticide and fungicide plot showed low populations without damage in the first observation (Aug. 16), but high population in the second observation (Sep. 2). Though population of BPH were distributed as a Poisson (random type) at low densities but at higher population levels, they had the negative bionomial distribution (clumping type). As BPH build up their population at a given point, the population shows a high level of aggregation. Insect population were very important in evaluating varietal resistance. However, since their response varied depending upon environmental conditions such as layout of planting, plant damage and distribution pattern, the population of BPH should be taken relative evaluation. There is a need for a large number of replication for desirable evaluation.

Milyang 42, Sinkwang, Sinsunchal and Daechang, which had less than 100 insects per hill on 18th August, showed high populations on the second of September because they had vigorous plants which allowed BPH to build up their population in the no insecticide and fungicide plot. Whereas, Sangpung, Nongbaeg, Seonam, Bogkwang and 5 others, which had high populations of more than 300 insects per hill on 18th August, had low populations on second September because of plant damage due to high insect populations in no insecticide plot.

In general, population of BPH in the observation on 18th August were higher than those on the second of September observation in the NIA plot, however, the populations were higher in the second of September than those on 18th August in the NIFA plot. It was considered that due to fungicide (Benasol-G and Neozin-Lq) applications on 26th July the NIA plot had smaller populations than the populations of NIFA plot. Fungicide application may help to stimulate the growth of rice plants by controlling diseases which allow insects to multiple well on the good host plants. Fungicide application may have positive effects on the insects relationship with natural enemies, microclimate, and other environmental conditions. However, Lee(1979) reported that Oryzae G. could have 29% mortality to BPH in the pots 24 hours after application. Some fungicides applications are capable of controlling insects and diseases. The former effect was considered to be larger than the latter effect in this experiment.

The hybrid cultivars were hopperburned later than susceptible Japonica cultivars. The hybrids showed high yields of more than 4.3 t/ha, whereas Japonica cultivars showed less than 4.5 t/ha. in the no insecticide plot. Low population on hybrids resulted from the layout of plots which were transplanted to hybrids and Japonicacultivars. There were 6 resistant cultivars among 13 cultivars, but no resistant cultivars among Japonica cultivars. BPH can be distributed easily to near-cultivars among Japonica cultivars, but not easily among hybrid cultivars.

Though carbofuran and BPMC were applied in the NFA plot on August 20, 21, respectively, high population of brown planthoppers were observed on the Bogkwang, Seongjeon, Nongbaeg, Sangpung, Guanauk, and Seonam. Low effectiveness of carbofuran was the result of low activity of old plants for systemic chemicals. Also its BPMC dust might not have penentrate into the basal parts of rice plants due to dense plant surface.

There were big differences in plant damage among the tested cultivars. Samgang, Gaya, Hangangchal and Cheongchong, which had very low population, showed no damages, but Milyang 30, Wonpung, Seokwang, Baegyang, Milyang 23, Sinkwang and Seolauk were partially hopperburned, and others were completely hopperburned. Late hopperburns were observed on Milyang 30 and Wonpung (Sep. 13), Milyang 23 (Sep. 8), Seokwang and Baegyang (Sep. 7), and Milyang 42 and Chucheong (Sep. 6). Early hopperburns were observed on Bogkwang (Aug. 17), Sobaeg and Seongjeon (Aug. 18), Nongbaeg (Aug. 23), Odae (Aug. 24), and Guanauk (Aug. 25). Hopperburn occurs from high insect population. On the other hand, hopperburns can also be influened by the time of senescence of the rice plants which are different depending on short or long term varieties. Short term cultivars such as Nongbaeg, Odae, Seolauk, Sobaeg, and Songjeon began hopperburns by mid and late August, and long term cultivars such as Dongjin, Seonam, Nagdong, Seomjin, and Chucheong began in early September. Short term cultivars usually begin mature grain stage in late August to early September, and long term cultivars in mid to late September.

The yields were generally higher in the order to no fungicide plot, no insecticide plot, and no insecticide and fungicide plot. The result means that insects control got most important in yields. High yields were observed from Samgang (6.1 t/ha), Gaya (5.9 t/ha), Hangangchal (5.6 t/ha), Seokwang (5.2 t/ha), and Milyang 30 (5.1 t/ha) in the no insecticide plot. Whereas Seongjeon (2.1 t/ha), Sobaeg (2.5 t/ha), Chucheong (2.8 t/ha) and Palguem (2.9

Table 1. The populations of brown planthopper (BPH), plant damages and yields of the different rice cultivars in paddy fields, Haenam, in 1983[a]

Variety	No insecticide: No. BPH/hill Aug. 18	No insecticide: No. BPH/hill Sep. 2	No insecticide: Date of[b] hopper-burning First	No insecticide: Date of hopper-burning All	No insecticide: Yield (t/ha)	No insecticide & fungicide: No. BPH/hill Aug. 18	No insecticide & fungicide: No. BPH/hill Sep. 2	No insecticide & fungicide: Yield (t/ha)	No fungicide: No. BPH/hill Sep. 2	No fungicide: Yield (t/ha)	Yield increase (%) with Insecti[c]-cide	Yield increase (%) with Fungi[d]-cide
Samgang	1	0	—	—	6.1	0	1	6.2	0	8.0	29	−2
Gaya	2	0	—	—	5.9	1	0	5.8	0	6.5	12	2
Hangangchal	3	1	—	—	5.6	1	4	5.2	0	7.0	35	8
Seokwang	182	557	S. 7	—	5.2	620	495	4.7	2	6.4	36	11
Milyang 30	56	71	S. 13	—	5.1	101	64	4.6	1	6.4	39	11
Baegyang	199	31	S. 7	—	5.0	26	31	4.5	13	6.1	36	11
Milyang 23	39	237	S. 8	—	4.9	188	129	3.7	5	7.2	95	32
Milyang 42	257	379	S. 6	S. 15	4.7	98	590	4.2	5	7.5	79	12
Sinkwang	256	105	S. 4	—	4.7	63	910	3.9	7	6.3	62	21
Sinsunchal	200	81	S. 2	S. 9	4.6	94	1,115	3.4	43	5.8	71	35
Cheongcheong	2	2	—	—	4.6	1	1	4.5	1	5.3	18	2
Deachang	433	146	S. 2	S. 7	4.4	89	705	3.1	63	5.4	74	42
Sangpung	730	94	S. 2	S. 9	4.3	161	1,135	2.9	150	5.6	93	48
Nongbaeg	375	80	A. 23	S. 11	4.3	51	565	2.6	223	5.0	92	65
Wonpung	40	76	S. 13	—	4.3	201	885	4.2	6	5.7	60	2
Dongjin	224	114	S. 4	S. 10	4.2	135	1,200	2.7	26	5.3	96	59
Seonam	568	66	S. 1	S. 8	4.0	80	1,060	2.6	104	5.0	92	54
Pungsan	262	368	S. 1	S. 7	3.8	485	670	3.2	7	6.0	88	19
Bogkwang	677	90	A. 17	S. 4	3.8	97	810	2.6	540	3.9	50	46
Odae	440	75	A. 24	S. 11	3.7	235	940	3.2	30	4.9	53	16
Seolauk	299	40	A. 30	—	3.7	78	590	3.0	33	5.0	67	23
Nagdong	219	106	S. 5	S. 10	3.4	205	1,035	2.2	66	4.2	91	55
Seomjin	228	121	S. 5	S. 10	3.1	250	890	1.7	18	2.9	71	82
Guanauk	720	258	A. 25	S. 1	3.1	235	995	1.6	145	4.8	200	93
Bongkwang	1,150	282	S. 1	S. 9	3.0	315	1,110	1.5	33	5.4	260	100
Palguem	351	640	S. 2	S. 10	2.9	109	805	1.3	41	4.2	223	123
Chucheong	365	102	S. 6	S. 10	2.8	360	860	1.7	13	4.6	171	65
Sobaeg	257	20	A. 18	S. 10	2.5	65	630	2.3	33	4.0	74	9
Songjeon	423	188	A. 18	S. 1	2.1	168	790	1.2	240	3.6	200	75

[a] Only fungicides were applied in the no insecticide plot, and only insecticides in the no fungicide plot.
[b] Date when first rice plant was dead all pints A: August, S: September.
[c] Yield increase with insecticide: (yield (t/ha) in no fungicide/yield(t/ha) in no insecticide & fungicide) × 100.
[d] Yield increase with fungicide: (yield (t/ha) in no insecticide/yield(t/ha) in no insecticide & fungicide) × 100.

t/ha) produced low yields. The results of yields in other plots were similar to those of no insecticide plot. The effect in resistant cultivars to insect pests can be observed from the yields (%) when the no fungicide plot yield is divided by the yields in no insecticide and fungicide plot. Yield increases (%) with insecticide were low on the Gaya(12%), Samgang(29%) and Hangangchal(35%), but high on the Bongkwang(260%), Palguem(223%), Songeon (200%). On the other hand when fungicides were applied in no insecticide plot, yield increases (%) were low for Samgang(−2%), Gaya(2%), Cheongcheong (2%) and Hangangchal (8%), but high for Palguem (23%), Bongkwang (100%), Guanauk (98%) and Seomjin (82%). Yield losses of resistant varieties such as Samgang and Cheongcheong to BPH in the NIA plot was caused from white backed planthopper, rice stem maggot, striped rice borer, leaf folder and other insects except the BPH. High yields in the no fungicide plot might have been influenced by the application of carbofuran which was reported to promote growth of rice. All varieties except Samgang showed higher yields in the no insecticide plot than in no insecticide and fungicide plot.

Songjeon had the lowest yield among the tested varieties. The low yield was due to damaged from rodents as well as insects and diseases. Rodents attacked very short term varieties (early mature varieties) more than the long term varieties (late mature varieties) because there was no feed for rodents in the paddy fields prior to panicle formation by the short term varieties. Palguem as a late maturing variety was damaged seriously because it was attacked by high populations of BPH before panicle initiation.

摘 要

벼멸구에 對한 벼品種間의 被害와 收量을 調查하였다. 1983年 全南 海南에서 29個 벼品種을 殺虫劑無散布區, 殺虫 및 殺菌劑無散布區, 殺菌劑無散布 두어 移秧하고 虫密度, 벼枯死時期, 收量을 調查하였다.

三剛벼, 伽倻벼, 漢江찰벼, 靑靑벼는 극히 낮은 密度와 被害가 없었고 密陽 30號와 圓豊벼는 中間程度의 密度와 被害를 보였고 그 以外 品種은 높의 密度와 枯死現狀을 나타냈다. 殺虫劑無散布에 의한 收量 減收效果가 적었던 品種은 伽倻 '(12%), 三剛벼(29%), 漢江찰벼(35%)였고 減收效果가 컷던 品種은 福光벼(260%), 八錦(223%), 松前벼(200%), 冠岳벼(200%)였다.

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