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Leovegildo B. Mante, JR
Chair Agricultural Sciences Department, College of Agriculture Fisheries, and Natural Resources, University of Eastern Philippines

Correspondence:
Leovegildo B. Mante, JR
Chair Agricultural Sciences Department, College of Agriculture Fisheries, and Natural Resources, University of Eastern Philippines

Tillage and crop establishment of aromatic rice's: Their influence on the population dynamics of insect pests

Leovegildo B. Mante, JR

Abstract
A field experiment was conducted at University of Eastern Philippines (UEP) experimental area, to determine the influence of the different methods of tillage and crop establishment on the occurrence and population dynamics of insect pests; plant growth and yield response of introduce aromatic rices cultivars,Kasturi, Basmati 370 and basmati 385 and local variety kalinayan.
Transplanted basmati 370 and basmati 385 in both methods of tillage produces the highest number of productive tillers; kalinayan and kasturi obtained the most non-productive tillers. Transplanted kasturi in payatak and in conventional tillage produced significally the longest panicle followed by kalinayan, basmati 385 and basmati 370. Transplanted and direct seeded kalinayan in payatak and in conventional tillage obtained the greatest filled grains followed by the conventional basmati 370 and kasturi. Transplanted basmati 370 and basmati 385 in payatak and conventional tillage produced the heaviest 1000 grain weight while kalinayan, the lightest. Transplanted basmati 370 significally obtained the highest grain yield at 4.51 t/ha. Followed by kasturi, 3.21 t/ha; kalinayan, 2.78 g/ha. And basmati, 385 2.77 t/ha.
Direct seeded and transplanted kalinayan was the tallest cultivar tested, be it planted in payatak or in conventionally prepared land areas. Furthermore, kalinayan obtained the biggest leaf area index followed by basmati 385, basmati 370 and kasturi, the smallest. Direct seeded basmati 385 flowered earliest followed by basmati 370, kasturi and kalinayan.
Transplanted rice had the lowest insect pest incidence. The method of land preparation did not affect insect pest incidence; however, basmati 370 was observed most resistant to insect pest infestation while basmati 385 ranked second. Kasturi and kalinayan exhibited less resistance to insect pest infestation.
The dominant natural enemies monitored included wolf spider *Lycosa pseudoannulata* (boesenberg and strand), long horned grasshopper *Conocephalus longipennis* (de haan), damselfly *Agriocnenis femina* (Brauer), lynx spider *Oxyopes javanus* (Thorell), long jawed spider *Tetragnatha maxillosa* (Throrell) and lady beetles *Micrapis crocea* (Mulsant). The low population buildup and infestation of insect pests was attributed to the high population count of natural enemies in every plant growth stage.

Keywords: Aromatic rices, Tillage, Crop establishment, Insect pests, Population dynamics, Payatak /soil trampling

1.0 Introduction

Aromatic or scented rice cultivars have an associated flavor in addition to their high milling returns and good cooking qualities. These varieties are generally preferred over non-aromatic type in the world trade, hence earn premium prices (Petrov et al., 1996). Consequently, a considerable foreign exchange is being generated by the exporting countries.
In the Philippines, aromatic rice likewise command higher prices than non-aromatic ones. The cultivar azucena, an upland rice which is indigenous to the country, has the highest price in the local market (Hu,1991)
With the increasing domestic and international demand for aromatic rice, the Philippine rice industry is presented with a challenge to intensify and sustain the production of these crops.
Research efforts therefore, should be geared to consider the relationship between given cultural practices and the response of the introduced aromatic cultivar growth under existing environmental conditions. The generated information may serve as a tool for the development of a component technology that would in effect, encourage farmers to go into aromatic rice production.
This study intended to generate information on the influence of the different methods of land preparation and crop establishment on the occurrence and population dynamics of insect

pests in the aromatic cultivars basmati 370 and 385 as well as Kasturi and the check variety Kalinayan.

Materials and Method

Experimental Design and Treatment

A 2 x 2 x 4 factor experiment arranged in randomized complete block design (RCBD) with three replications was used in this study. Two methods of land preparation served as Factor (A), two methods of crop establishment as Factor (B) and four varieties of aromatic rice as Factor (C).

The following treatments were used in the study:

Factor A: Land preparation

T_1 – Traditional "payatak" method of land preparation

Payatak farming is a traditional way of lowland rice production practices ever since by the farmers in Samar. The word "payatak"means to trample the soil surface. Thus, "payatak" farming got its name from the manner in which the land is prepared for rice planting. Land preparation is done by trampling the surface soil one to two times using two or more carabaos. In this study, the said method was performed two times. The first operation was done a month prior to planting; the second operation followed three weeks after the first operation.

T_2 – Conventional Tillage (one plowing and one harrowing) was made then leveled ready for planting. All operations were done within a month.

Factor B: Crop Establishment

P_1 –Transplanted

Seedlings of Basmati 370, kasturi, Basmati 385 and kalinayan, which were 25 days old, were transplanted to the prepared plots at about three seedlings per hill to a planting of 20 cm x 20 cm.

P_2- Direct Seeded

The seeds of Basmati 370, kasturi and Basmati 385 and kalinayan were soaked for 24 hours and then incubated for another 36 hours. Pre-germinated seeds were broadcasted into the designated treatment plot.

Factor C: Rice Variety

The rice varieties used were:

V_1- Basmati 370 – This cultivar which originated in India matures within 105 days and is a semi-dwarf and aromatic variety. It has an average yield of 3.69 tons per hectare.

V_2- Kasturi – This cultivar which also originated in India matures within 108 days and is a semi dwarf and aromatic variety. It has an average yield of 1.6 tons per hectare

V_3- Basmati 385- this variety matures in 104 days and sis a semi dwarf and aromatic variety with an average yield of 3.6 tons per hectare.

V_4- kalinayan (local check)- This is an upland aromatic rice variety commonly grown in Samar. It is tall variety that matures within 118 days and has an average yield of 2.78 tons per hectare.

Land Preparation

A total land area measuring 1,423.75 Sq.m. (83.75 m x 17 m) was used in this study. The area was divided into three blocks; each block measuring 83.75 m x 5 m (418.75 m2). One meter alleyway was provided in between blocks. Each block was further subdivided into sub-sub treatment plots each measuring 5 m x 5 m (25 m2). An alleyway of 0.25 meter was provided in between treatment plots.The land was prepared a month prior to planting.

Two methods of land preparation served as Factor A. T1-Taditional "Payatak" method of land preparation, while T2-Conventional tillage, one plowing and one harrowing then leveled ready for planting.

Fertilizer Application

Split application of 69-20-0 NPK kg/ha was done where the first application of 2 bags 16-20-0 (Ammophos) and 1 bag urea per hectare or 250 grams ammophos and 125 grams urea per plot was applied basally. The second application of 1 bag urea/hectare or 125 grams per plot was made before panicle initiation (40DAS).

Harvesting

Crop was harvested after all the grains reached 85% maturity. Four sample hills were taken in every corner outside the harvest area in each plot by cutting the stem close to the ground. This was used for the determination of the yield component.

Damage Assessment and Sampling Methods

Whorl Maggot

The damage was assessed at seedling (20 DAS) and vegetative stage (21DAT). Ten hills per plot were observed and damage was compared using the scale as follows (Adalla, 1998).

Rating Scale

Scale	Description
0	No damage
1	Not less than 2 leaves/hill damage
3	2 or more leaves/hill but less than 33% of the leaves damaged
5	33 to 50% leaves damaged
7	More than 50% of the leaves damaged but no broken leaves
9	More than 50% of the leaves damaged with some broken leaves

Leaf folder

Ten (10) hills per plot were selected at random weekly to examine the infestation of leaf folder. The damage was assessed based on the percentage of leaves infested

$$\% \text{ leaf damage} = \frac{\text{No. of damaged leaves/10 hills}}{\text{Total number of leaves/10 hills}} \times 100$$

Yellow Stem

Ten (10) hills per plot were taken at random to determine infestation of stem borer. Dead heart assessment was made at vegetative stage (30DAT), while whitehead damage was assessed (10) days before harvesting. Dead hearts and whiteheads percent incidence was computed using the following formula:

$$\% \text{ dead heart} = \frac{\text{No. of dead heart infested hills}}{\text{Total No. of tillers observed in Infected hills}} \times \frac{\text{No. of infested hills}}{\text{Total hills observed}} \times 100$$

$$\% \text{ Whiteheads} = \frac{\text{No. of whiteheads}}{\text{Total No. of panicles Observed}} \times \frac{\text{No. of infested hills}}{\text{Total hills observed}} \times 100$$

Green Leafhoppers

Green leafhoppers were monitored using sweep net. Ten sweeps were made per plot weekly. The collected samples were placed in labeled vials with 80% ethyl alcohol and

were bought to the laboratory for sorting, counting and recording.

Brown Plant Hopper

Brown plant hopper was monitored by direct observation of the base of the sample hills. This was done using 10 randomly selected hills per plot by crossing the plot diagonally.

Armyworm and Cutworm

Armyworm and cutworm damage was monitored weekly through direct observation on the ten randomly selected sample hills per plot. Adult monitoring was made using sweep net. Ten sweeps were made per plot weekly. Collected insects were brought to the laboratory for sorting, identification, counting and recording.

Rice bug

Rice bug was monitored using a sweep net. Ten sweeps were made per plot weekly from reproductive to ripening stage. Collected samples were placed in labeled vials with 80% ethyl alcohol and were brought to the laboratory for sorting, counting and recording.

Case worm

Case worm damage was determined through direct observation on the ten randomly selected sample hills per plot. Adults were monitored using a sweep net. Ten sweeps were made per plot weekly. Collected samples were brought to the laboratory for counting and recording.

Insect identification

Collected specimens were initially identified using taxonomic keys by Donald J. Borror and Dwight M. DeLong. Further identification was done by comparison to other verified species.

Data Gathered

The following data were collected:

1. Plant height at harvest (cm)

This was the average height taken from the base to the tip of the tallest leaf at harvest from ten randomly selected sample hill plants taken from the four corners of each treatment plot. These plants were used in gathering other data.

2. Leaf Area Index

Leaf area index was computed based on the following formula:

$$LAI = \frac{L \times W \times CF}{AC} \times \text{No. of tillers}$$

Where: L = Length
W = Width
CF = Correction Factor (0.5)
AC = Area covered (Distance of Planting)

3. Number of days from seeding to 50% heading

Ten randomly sample hills per plot were used to determine the number of days from seeding to 50% heading. Date of flowering was recorded when 50 percent of the whole population bore panicle.

Yield and Yield Components

1. Number of Productive and Unproductive Tillers

Using the sample hills obtained from the corners of each plot; the number of productive tiller was determined by counting the number of panicles then dividing the number of panicles with the number of hills. The same procedure was used in obtaining the data for unproductive tillers.

2. Grain Yield. Grain yield was obtained from an area of 2 m x 3 m at the center of each experimental plot. Grain yield was reported at 14% moisture content. This was computed using the following formula.

$$\text{Grain Yield} = \frac{100\text{-MC}}{86} \times \frac{\text{Weight of sample in kg}}{6\ m^2} \times \frac{10.000\ m^2}{1\ ha} \times \frac{1\ ton}{1{,}000\ kg}$$

Ten panicles were randomly selected from the ten sample hills collected in the four corners of each experimental plot. This was used to estimate the following yield components

1. Length of panicle
2. Number of filled grains
3. Number of unfilled grains
4. 1000 =- grain weight in grams

Insect Pest Population and Infestation

1. Percentage of dead heart per hill

This was the total number of dead heart in ten sample hills divided by the total number of tiller multiplied by 100

2. Percentage Whitehead per hill

This was the total number of whitehead divided by the number of panicles taken from ten randomly selected sample plants multiplied by 100.

3. Average Number of Green Leafhoppers per Tillers

This was the total number of green leafhopper (nymph and adult) collected divided by the ten sweeps.

4. Average Number of Brown Plant Hopper per Tillers

This was the total number of plant hoppers sampled (nymph and adult) divided by the number of sample hills

5. Population Count of Rice Bug per Treatment

This was the total number of rice bug caught in ten sweeps per treatment.

6. Percentage Leaf folder infestation

This was the number of damaged leaves per 10 sample hills over total number of leaves sampled x 10

7. Percentage Whorl Maggot Infestation

This was the percent (%) damage of whorl maggot determined by using the rating scale presented in the damage assessment.

Agro-Climatic Data

Rainfall, temperature, relative humidity, day length, wind velocity and bright sunshine were monitored during the conduct of the study.

Statistical Analysis

All data gathered were statistically analyzed using Factorial in Randomized Complete Block Design. The analysis of variance (ANOVA) was computed using the Systat 9.0 program in linear model. Mean treatment difference was tested using the tukeys test.

Results and Discussion

Crop Environment

The average rainfall, wind velocity, relative humidity, temperature, day length and bright sunshine per growth stages of the test varieties were monitored.

The climatic classification of Northern Samar falls under Type II in the old classification and Type G in the new

classification. This type is characterized as rainy season with a very pronounced maximum rain from November to January or has an even distribution of rainfall with no marked seasonality (Huke, R.E.)

Environmental condition was noted favorable during the seeding and vegetative stages than during the reproductive stage of the rice plants. The recorded rainfall, wind velocity and day length during the reproductive stage were 19.97 (mm), 3.29 (mps) and 691.46 minute, respectively. This reading was higher compared to the other growth stages. The reproductive growth period was mainly rainy weather. Fair weather was experienced during the ripening stage of the rice plants.

Plant Growth

Plant height (cm)

Plant height was significantly affected by the varieties tested, method of land preparation and crop establishment. The analysis of variance showed a significant interaction between land preparation and variety and highly significant interaction in crop establishment and variety as well as the combined effect of land preparation, crop establishment and variety.

The direct seeded and transplanted Kalinayan was the tallest cultivars tested whether it was planted in "payatak" or in conventional land prepared areas with 137.05 cm and 136.36 cm, respectively (Table 1). Furthermore, direct seeded kalinayan were significantly taller than transplanted Kalinayan in both land cultivation practices.

The transplanted Basmati 385 in conventional tillage was taller than the direct seeded Basmati 385 planted in areas prepared through the "payatak" method. The same height was found in Kasturi planted in areas cultivated through conventional means. Basmati 370 was the shortest variety especially those transplanted in "payatak" and conventional cultivated areas with 93.55 and 93.65 cm, respectively. The difference in height among the test varieties can be due to the genetic make-up of the cultivars plus the contributory effect of the treatments.

Table 1: Plant height of Different aromatic rice varieties as influenced by method of land preparation and crop establishment (cm)

		Variety				
Tillage	Crop Establishment	V1 Basmati 370	V2 Kasturi	V3 Basmati 385	V4 Kalinayan	Tillage Means
Payatak	Transplanted	95.33	103.80	101.96	131.93	107.76
	Direct Seeded	98.132	92.78	103.45	136.36	
Conventional	Transplanted	95.65	103.57	105.11	131.62	108.50
	Direct Seeded	97.05	96.22	103.81	137.05	
	Variety Mean	95.64	99.09	103.58	134.23	
Crop Establishment Means						
Transplanted			108.14			
Direct Seeded			108.12			

Treatment means followed by the same letter(s) are not significantly different at 5% level using "Tukeys test" CV=1.03%

Leaf Area Index

Crop establishment and variety significantly affected the leaf area index. Transplanted and direct seeded crop differed significantly by 0.46 cm. The difference can be due to the distance between hills affecting the leaf orientation of the plants. In like manner, varieties exhibited significant variations. Kalinayan obtained the biggest leaf area index while kasturi, the smallest. Basmati 385 and 370 did not differ with 1.55 and 1.46 leaf area index. The index difference among varieties can be attributed to the respective inherent trait.

Table 2: Leaf area index of the different aromatic rice varieties as influenced by method of land preparation and crop establishment.

		Variety				
Tillage	Crop Establishment	V1 Basmati 370	V2 Kasturi	V3 Basmati 385	V4 Kalinayan	Tillage Means
Payatak	Transplanted	0.95	0.97	0.95	1.60	1.40
	Direct Seeded	1.84	0.90	2.26	1.77	
Conventional	Transplanted	1.23	1.18	1.04	1.97	1.52
	Direct Seeded	1.85	0.89	1.96	2.10	
	Variety Mean	1.46	0.98	1.55	1.86	
Crop Establishment Means						
Transplanted			1.23^{L}			
Direct Seeded			1.69^{M}			

Treatment means followed by the same letter(s) are not significantly different at 5% level using "Tukeys test" CV=13.94 %

Number of Days from Seeding to 50% Heading

The number of days from seeding to 50% heading was significantly affected by both crop establishment and variety. However, no interaction effect between the factors was observed.

The crop establishment of aromatic rice significantly influenced the number of days to flower. Direct seeded plants flowered earlier than those transplanted, probably due to transplanting shock and delayed recovery experienced in transplanted cultivars.

Significant differences among varieties were also observed. Basmati 385 flowered earlier (68.83 DAS) followed by Basmati 370 and kasturi with 72.49 and 75.49 DAS respectively. On the other hand, kalinayan flowered late with 91.58 days. This finding is consistent with that of Salas (1999) claiming that Basmati 370 flowered in 62

DAT and 72 DAT for kasturi. The difference in days to flower can be attributed to the genetic make-up of the varieties tested.

Yield Components

Number of Non-Productive Tillers

Non-productive tiller was significantly influenced by crop establishment and varieties tested. Interactions among treatments were highly significant. Basmati 385 and kasturi transplanted in both cultivations obtained the highest number of non -productive tillers followed by Basmati 370 with 2.7, 2.63, 2.60, 2.40 and 2.37. Basmati 370 direct seeded in "payatak" tillage gave the least non-productive tillers. The greatest unproductive tiller in kasturi and Bamati 385 was due to the occurrence of bacterial leaf blight (BLB) during the vegetative stage. Considering that leaves were the most affected parts lesser photosynthesis could have been produced resulting in a reduced number of tillers that have borne panicles. The results indicated that transplanted rice produced more non-productive tillers than the direct seeded plants. The study also showed that transplanted rice produce more tillers, hence more non-panicle bearing tillers. A similar finding was observed in the study conducted by Salas (1999).

Productive tillers

Both crop establishment and the test varieties significantly affected the number of productive tillers. Basmati 370 transplanted in both methods of land preparation produced the highest number of productive tillers followed by Basmati 385 transplanted in conventional and "payatak" prepared areas with 12.53, 12.23, 11.60 and 9.83. Kasturi transplanted in conventional land preparation only produced 8.20. kalinayan and kasturi directly seeded in both " payatak" and conventional cultivated areas produced the least tillers.

The interaction between crop establishment and variety was found highly significant. Direct seeded rice regardless of variety and method of tillage produced significantly lower productive tillers. This was due to the competition among plants since direct seeded rice requires higher nutrient value per unit area.

Length of Panicle

Crop establishment and variety significantly affected panicle length. Kasturi transplanted both in payatak and conventional land prepared areas produced the significantly longest panicle (31.41 cm) followed by Kalinayan (29.00 cm). Basmati 385 and 370 were found to have produced the shortest with 28.65 and 28.14 cm, respectively. The difference in panicle length between cultivars can be due to the differences in their inherent characteristics.

Average Number of Filled Grains

Filled grains of cultivars tested were significantly affected by the cultural practices employed.

Highly significant interactions in all treatments were observed. Kalinayan, the check variety, both transplanted and direct seeded obtained the highest number of filled grains be it grown in "payatak" or in conventional land prepared area. Among the introduced varieties, Basmati 370 and Kasturi showed good response when grown through transplanting in both methods of land preparation.

The significant difference in filled grains can be attributed to the treatment effect, particularly the method of crop establishment wherein grain filling in direct seeded plants was affected by insufficient sunlight due to the leaf shading effect among plants.

Average Number of Unfilled Grains

Number of unfilled grains was significantly affected by crop establishment, variety and land preparation. The analysis of variance showed highly significant interaction between treatments.

Transplanted Kalinayan and Kasturi in "payatak" tillage had the highest number of unfilled grains with 33.90 and 30.93, respectively. Basmati 385 direct seeded in conventional prepared areas and Basmati 370 transplanted in "payatak" tillage gave the least number of unfilled grains with 15.3 and 16.00, respectively. The difference in the number of unfilled grains of the different treatments can be due to the difference in occurrence of insect pest.

1000-Grain Weight (gm)

Similar to filled grains, the 1000 grains weight was significantly affected by land preparation, crop establishment and varieties tested.

Kasturi and Basmati 385, transplanted both in "payatak" and conventional ways of land cultivation produced the heaviest 1000 grams but did not differ from the direct seeded in conventional tillage. On the other hand, the same weight was noted in transplanted and direct seeded Basmati 370 under "payatak"tillage. Kalinayan produced the lightest 1000- grain weight be it transplanted or direct seeded in conventional and "payatak" tillage. Although there was interaction between treatments still the significant differences possibly were due to the genetic characteristics of the varieties. This finding is consistent with that of Yoshida (1981) who reported that under most conditions, 1000 grains of filled crop is a very stable character.

Grain Yield (t/ha)

Crop establishment and variety significantly affected grain yield. However, no interaction was observed between the two factors. The analysis of variance revealed that transplanted plants obtained significantly higher yield than the directly seeded rice plants. This finding affirmed the findings of Lagwal et.al. (1994) who reported that the distance of planting influence the grain yield of Basmati 370, but contradicts the findings of Grospe (1998) who reported that Basmati 370 and Kasturi responded more to direct planting than to the transplanted.

In like manner, significant differences were observed in the different varieties tested. Basmati 370 obtained the highest yield of 4.51 ton/ha followed by Kasturi, 3.21 ton/ha. Kalinayan and Basmati 385, on the other hand, produced the low yield of 2.78 and 2.77 ton/ha., respectively. The high yield of the transplanted Basmati 370 can be due to its high produced tiller count, relatively high filled grains and heavier grain weight. Further, this study showed a higher yield compared to the result of preliminary studies in the Philippines conducted and reported by Grospe (1998).

Insect Pest Occurrence and Percent Infestation

Green Leafhopper Population Green leafhopper *Nephotettix virescens*(Distant) nymph and adult population was affected by both variety and crop establishment, while

method of land preparation did not show any significant contribution to the green leafhopper occurrence.

Kalinayan appeared most susceptible to green leafhopper *Nephotettix virescens*(Distant) followed by Kasturi, Basmati 370 and 385. An increasing population trend of nymph and adult green leafhopper *Nephotettix virescens*(Distant) was observed from seedling to ripening stages. Further, the increasing population can be attributed to the favorable weather. This finding is consistent with the report of who claimed that green leafhopper is most prevalent during the wet season. Furthermore, rainfall and relative humidity affect the population dynamics of hopper IRRI (1979).

Method of crop establishment influenced green leafhopper *Nephotettix virescens*(Distant) population, direct seeded higher green leafhopper *Nephotettixvirescens*(Distant) population count compared to transplanted rice. The same result was reported by IRRI (1985) citing that insect population on transplanted rice is extremely lower.

White backed Plant Hopper Population

The population trend of white backed plant hopper *Sogatella furcifera* (Horvath) differed greatly among varieties. Kalinayan appeared to be highly preferred by white backed plant hopper *Sogatella furcifera* (Horvath) followed by Kasturi, Basmati 370 and 385. Pest abundance was found increasing from seedling to vegetative stage. The unstable WBPH population trend can be due to the fluctuating rainfall, wind velocity, relative humidity and temperature which occurred in the seedling and vegetative stages which favorably increased their incidence. High rainfall, wind velocity and a relatively fair humidity and temperature decreased the pest occurrence. These findings support the report of Abraham (1978) who revealed that high humidity and optimum temperature appear to be important factors causing hopper abundance.

Lower population of white backed plant hopper *Sogatella furcifera* (Horvath) was monitored in transplanted rice compared to the direct seeded. On the other hand, method of land preparation did not contribute any difference in white backed plant hopper *Sogatella furcifera* (Horvath) occurrence.

The high population count of white backed plant hopper *Sogatella furcifera* (Horvath) in the direct seeded rice was due to the spacing effect. The same findings on the effect of insect pest abundance were reported by Ross et.al, (1982) who cited that plant spacing and cropping pattern affect insect pest abundance.

Brown Planthopper Population

Brown plant hopper *Nilaparvata lugens* (Stal) population trend was positively affected by crop establishment and variety. Brown plant hopper *Nilaparvata lugens* (Stal) incidence was not influenced by methods of land preparation.

The high population count of Brown plant hopper *Nilaparvata lugens* (Stal) was noted in direct seeded rice than in transplanted rice. This can be attributed to the close spacing of the plants in direct seeding affecting relative humidity that favored abundance of the pest. This findings coincides with the report of Dyck and Thomas (1980) who revealed that the population build-up of Brown plant hopper *Nilaparvat alugens* (Stal) is partly caused by higher plant density.

Kasturi was most attractive to Brown plant hopper *Nilaparvata lugens* (Stal) followed by Basmati 370, kalinayan and Basmati 385. However, its population count observed in all treatments was minimal. The minimal population obtained during cropping was possibly due to the high rainfall recorded.

Percent Whorl Maggot Infestation

Rice whorl maggot *Hydrellia philippina* (Fallen) incidence was influenced by both variety and planting method while method of land preparation did not show any contribution to the percent infestation of maggot.

Maggot attack started from seedling increasing in trend up to vegetative stage (21 DAT). The peak of infestation occurred in the vegetative sage and observed to decline thereafter.

Kasturi was noted as the most susceptible variety followed by Kalinayan, Basmati 370 and 385 with 5.87, 2.42, 2.37 and 1.86 percent of infestation respectively. This result coincides with the finding of that occurrence of the whorl maggot *Hydrellia philippina* (Fallen) increased at the vegetative stage of rice plant feeding on the central whorl leaf.

The difference in the cultivar response can be due to the inherent characteristics of the variety.

Higher incidence of rice whorl maggot *Hydrellia philippina* (Fallen) in transplanted rice is attributed to the shock recovery of transplanted rice that made the plants more susceptible compared to undisturbed direct seeded rice plants.

Percent Rice Leaf Folder Infestation

A Rice leaf folder Chaphalocrocis medinalis (Guenee) infestation rate was affected by variety and crop establishment.

Transplanted Kasturi obtained the highest percentage of infestation with 4.27 followed by Kalinayan (3.27) and Basmati 385 (1.43). On the other hand, minimal infestation was noted in Basmati 370 with 0.85 percent infestation.

An increasing infestation trend was noticed from the vegetative stage and its peak incidence in the reproductive stage. The high infestation recorded in the reproductive stage is associated with the high humidity and optimum temperature observed during the period. Similar findings were reported by Abraham (1978) who cited that high humidity and optimum temperature are the important factors that cause leaf folder abundance.

Rice Caseworm Infestation

Variety and crop establishment influenced rice caseworm *Nymphula depunctalis* (Guenee)

population build up. The method of land preparation had a negative impact on the pest occurrence.

Slight caseworm infestation occurred in transplanted rice during the seedling stage. A declining trend was recorded from the vegetative towards the reproductive stage while zero damage was noted in ripening stage.

Kasturi appeared susceptible to caseworm while minimal infestation occurred in Kalinayan, Basmati 385 and 370.

The good stand of transplanted rice attracted caseworm attack.

Armyworm/Cutworm

Armyworm *Mythimna separate* (Walker)/cutworm *Spodoptera litura* (Fabr.) percent infestation was positively

influenced by variety and plant establishment.

A higher rate of infestation occurred in direct seeded rice compared to transplanted rice. The difference in pest incidence can be due to plant spacing where the pest could easily hide/escape from their enemies in direct seeded rice. The method of land preparation showed a negative impact on pest incidence.

Percent infestation appeared higher in Kalinayan followed by Basmati 385, 370 and Kasturi during seedling stage. A decreasing pattern toward vegetative and reproductive stages except for Kalinayan which had a higher rate of incidence at the vegetative stage was monitored. The varied susceptibility levels among varieties can be attributed to the inherent characteristics of the cultivars.

Percent Dead Heart

Percent dead heart incidence differed among the varieties tested and crop establishment while method of land preparation showed a negative influenced on dead heart incidence. Transplanted cultivars obtained high rate of infestation during the vegetative stage. The high incidence can be due to the effect of the plant establishment (Ross et.al., 1982).

Dead heart incidence was due to yellow stem borer Scirpophaga incertulas (Walker) infestation. Stem borers were attracted most to Kalinayan variety followed by Kasturi, Basmati 385 and 370 with dead heart incidence of 2.37, 1.5, 0.32 and 0.27 percent, respectively. The same species of stem borer was revealed by Canapi et.al., (1994).

Percent Whitehead

Percent whitehead incidence pattern was observed similar to dead heart incidence wherein a different trend of damage was noted among the varieties tested and the crop establishment. The method of land preparation did not show any significant effect on whitehead incidence.

Direct seeded Kalinayan appeared to be the most susceptible variety followed by Basmati 385, Kasturi and Basmati 370 with 9.67, 3.7, 3.4 and 2.85% , respectively. This finding contradicts the two studies reported by Tantawi et.al. (1989) and Rillon et.al., who revealed that transplanted rice suffers higher stem borer infestation than direct seeded rice irrespective of variety.

Whitehead incidence was caused purely by yellow stem borer Scirpophaga incertulas (Walker) larval feeding damage during the reproductive stage. The same observation was noted by Catling et.al. (1987) who reported that stem borer causes damage (whiteheads) at the reproductive stage.

Rice Bug Population per Treatment

Rice bug *Leptocorisa oratorius* (Fabricius) population pattern appeared affected by both crop establishment and variety, while method of land preparation showed insignificant contribution to rice bug

Leptocorisa oratorius (Fabricius) occurrence.

Transplanted Basmati 385 was observed most susceptible to rice bug *Leptocorisa oratorius* (Fabricius) with 5.56 population count followed by Kasturi, Basmati 370 and Kalinayan with 3.37, 2.0 and 0.65 population count per treatment, respectively. An increasing population trend from reproductive to ripening stages was recorded. This finding contradics the report of Mandras et.al. (1996) who revealed that rice bug *Leptocorisa oratorius* (Fabricius) population is lower in the month of April, Leyte and Samar Island condition. The higher population count in Basmati 385 can be due to the erect panicle characteristic of the said variety.

Natural Enemies Occurrence

Natural enemies monitored included: wolf spider *Lycosa psuedoannulata* (Boesenberg and strand), lynx spider *Oxyopes javanus* (Thorell), long –jawed spider *Tetragnatha maxillosa* (Boenenberg and strand), orb spider *Agiope catenulate* (Doleschall), lady beetles *Micraspis crocea* (mulsant), wasp *Amauromopha accepta* (Ashmead), mind bug *Cyrtrhinus lividipennis* (Reuter), ophionea ground beetle *Ophionea ishi-ishii* (Habu), field cricket *Metioche vittaticolis* (Stal) dragonfly *Crocothenis servilia* (Drury), wasp *Tetratichus ayyari* (Rohwer), long horned grasshopper *Conocephalus longipennis* (Haan), damselfly *Agriocnenis femina* (Brawer) and water strider *Limnogenus fossarum* (Fabricius). An increasing population trend of *Lycos sp.*; *Oxyopes sp.*; *Tetragnatha sp.*; lady beetles, dragon fly and long horned grasshopper was noted from seeding to ripening stage. The population build-up of these natural enemies (beneficial insects) limited the occurrence and incidence of insect pests.

Conclusion

Based on the above findings, the following conclusions were drawn:

Transplanting aromatic rice in any method of land preparation significantly increased yield. Basmati 370 produced the highest yield of 4.52 ton/ha followed by Kasturi, 3.21 ton/ha; Kalinayan and Basmati 385 yielded the lowest, 2.78 ton/hectare and 2.77 ton/hectare.

Basmati 370 was found to be the most resistant to brown planthopper, whorl maggot, rice bug, rice caseworm with low incidence of green leafhopper, whitebacked planthopper and yellow stem borer.

Insect pest incidence varied among plant growth stages. Among the insect pests monitored, rice whorl maggot, yellow stem borer and rice bug were noted most attracted to Kasturi, Kalinayan and Basmati 385, respectively.

Insect pest incidence and population dynamics was significantly affected by crop establishment where high infestation of green leafhopper, brown planthopper, armyworm/cutworm and yellow stem borer was recorded in direct seeded than in transplanted aromatic rice.

Recommendation

Based on the findings, it is recommended that lowland rain fed farmers in Catarman, Northern Samar can engage in aromatic rice production with Basmati 370 as an introduced variety.

Furthermore, studies on disease resistance of aromatic rice should be conducted, especially on bacterial leafblight.

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