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Key Insect Pests and Weeds in Irrigated Rice Fields at Varying Fertilization Regimes

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Abstract:- The study Key Insect Pests and Weeds in Irrigated Rice fields at Varying Fertilization Regimes was conducted during July to December 2020 cropping season. It aimed to describe the occurrence of pests and weeds along with the soil characteristics and fertilizer regimes in different rice fields in RTRomualdez, Agusan del Norte. Relative to the objectives, findings were obtained. Pests and weeds are rising at the sampling sites which are contributory factors to the poor production of rice. Pests and weeds are significantly linked to fertilizer applications such as potassium (K) and nitrogen (N). The soil characteristics such as soil PH and soil phosphorus (P) of the farm sites in RTRomualdez Agusan del Norte are in the normal range. Organic matter (OM) content is low. However, soil potassium (K) is higher which is above the normal range when farmers applied more potassium fertilizers it may cause fixation rather than availability which aggravated further the occurrence of insect pests. Rice crops have a very low nitrogen (N) concentration and marginal potassium (K) levels. Regarding pest occurrence, Rottboellia cochinchinensis (Aguingay) grows more with increasing N concentration. The occurrence of pests is positively correlated to organic matter and phosphorus (P). Further, Nitrogen (N) is positively correlated to the occurrence of weeds. These implied that soil characteristics are significant factors in the occurrence of pests and weeds. The optimal use of potassium (K) and nitrogen (N) can be studied in the occurrence of pests and weeds. The growth of plant hopper and green leaf hopper can be further investigated at varying concentrations of organic matter and phosphorous content. A deeper study on the influence of Nitrogen uptake on the growth of *Rottboellia cochinchinensis* (Aguingay) is also suggested. Wide sampling sites may also be considered to understand the variability of pests and weeds.

Keywords: *Fertilization, Nitrogen, Pests, Potassium, Weeds.*

I. INTRODUCTION

Biodiversity plays a significant role in maintaining sustainable agronomic systems. To gain productive results, it is necessary to conserve diversity in agricultural systems. The importance of agricultural biodiversity involves socio-cultural, economic, and environmental elements. Transplanted rice fields are considered the most diverse agricultural systems on the planet (Horgan, 2017). According to Paiman et.al (2020), the growth of weeds in paddy fields poses a major biological threat to higher rice productivity and quality. Various cultural, chemical, biological, and physical practices affect the growth and composition of weeds in paddy fields. It was suggested that biological control of rice pests should be preferred over chemical control as biological agents account for 60% of mortalities of rice pests (Gangwar et al., 2018).

According to Cabasan et.al (2019), problems with crop pests challenge food security and poverty alleviation in Southern Philippines. Rice production is always coupled with pesticide application despite the known negative effects it can cause on health and the environment. Reviews presented above vividly reveal evidence that both weed and insect pests continue to threaten the production of rice all over the world.

Though the negative impacts of weeds and insect pests seem apparent, very little research is ever positioned on the rice fields in the RTR, Agusan del Norte. Hence, this study is positioned to determine key weeds and insect pests that inflict rice crops in the above-mentioned locale.

A. Objectives

- Described the occurrence of key pests and weeds during fertilization at different phases of rice in irrigated rice fields.
- Evaluated the Soil Characteristics of four irrigated sites.
- Assessed the N and K concentrations of rice crops in relation to pest occurrence.
- Correlation Analysis Between the occurrence of pests and weeds against soil characteristics.

II. METHODOLOGY

A. Sampling Sites

Four farmers' fields were used as sampling sites, with five sample quadrats selected randomly in each field. Figure 1 shows the distribution of farm sites in the geographical area of RTR, Agusan del Norte, Philippines.

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Fig 1. Geographical Map of the sampling sites

B. *Collection of Key Insect Pests*

A 50 square meters frame served as the main tool to generate estimates of abundance, species richness, and percentage cover. Five sweep nets were used during sampling which measured eight (8) inches in diameter, 12 inches in width, and 15 inches in height. An 180^0 arc counted one sweep up to five passed left and right in a five square meter (5m2) quadrat. Five samples were taken randomly per site in a zigzag direction. The collected insects were placed in transparent polyethylene plastics and tied with a rubber band and placed in the freezer for three hours to kill the insects and removed from the freezer for identification.

C. *Identification of Insect Pests*

Key insect pests were identified through a visual examination using the reference titled, “Common insect pests of rice and their natural biological control” by Peter A.C. (2015).

D. *Collection of Weeds*

The collection of weeds was done randomly at each site. Five samples were collected in a zigzag direction. Collected weed samples were placed in transparent cellophane and brought to the processing area for weed identification.

E. *Identification of Weeds*

Weeds were identified using the reference booklet titled “Weeds in Irrigated and Rainfed lowland rice fields in the Philippines by Donayre et al. (2016).

F. *Frequency of Collection of Insect Pests and Weeds*

The rice field insect pests and weeds were collected from the paddy fields and applied at varying fertilization regimes were done every 15 days between 6:00 to 8:00 in the morning after transplanting until the rice crop at the dough stage. This was further employed every 15 days after transplanting.

G. *Soil Sample Collection*

The soil sampling was done at four sites. Soil samples were taken randomly black method, phosphorus (P) was through the Olsen method, exchangeable potassium (K) was through the cold sulfuric acid method and soil texture was through feel method.

H. *Plant Tissue Analysis*

At harvest, rice was cut randomly at the base and threshed. Rice straws were collected at each site. Plant samples were submitted to the Regional Integrated Laboratories to assess the Nitrogen (N) & Potassium (K) concentrations. Plant samples were undergone through microwave-assisted aqua – regia digestion and determination through a microwave plasma–atomic emission spectrometer and total N was analyzed through the Kjeldahl method.

following the zigzag pattern and replicated five times. The soil samples were air-dried in the processing area of PhilRice Agusan and submitted to Regional Soils Laboratory to assess the soil pH, total organic matter, soil extractable phosphorus, and potassium. Soil pH was analyzed through a pH meter, organic matter (OM) was through the walkey and

I. *Rate of fertilizer*

The rate of fertilizer applications was taken through an interview with the farmers based on their actual application in their fields.

J. *Statistical analysis*

The data on the occurrence of weeds and insect pests were analyzed using frequency and percentage. Data on soil characteristics were treated using mean and standard deviations. Further, Pearson correlation analysis was employed to investigate the relationship between the occurrence of pests and weeds against soil characteristics

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III. RESULTS AND DISCUSSIONS

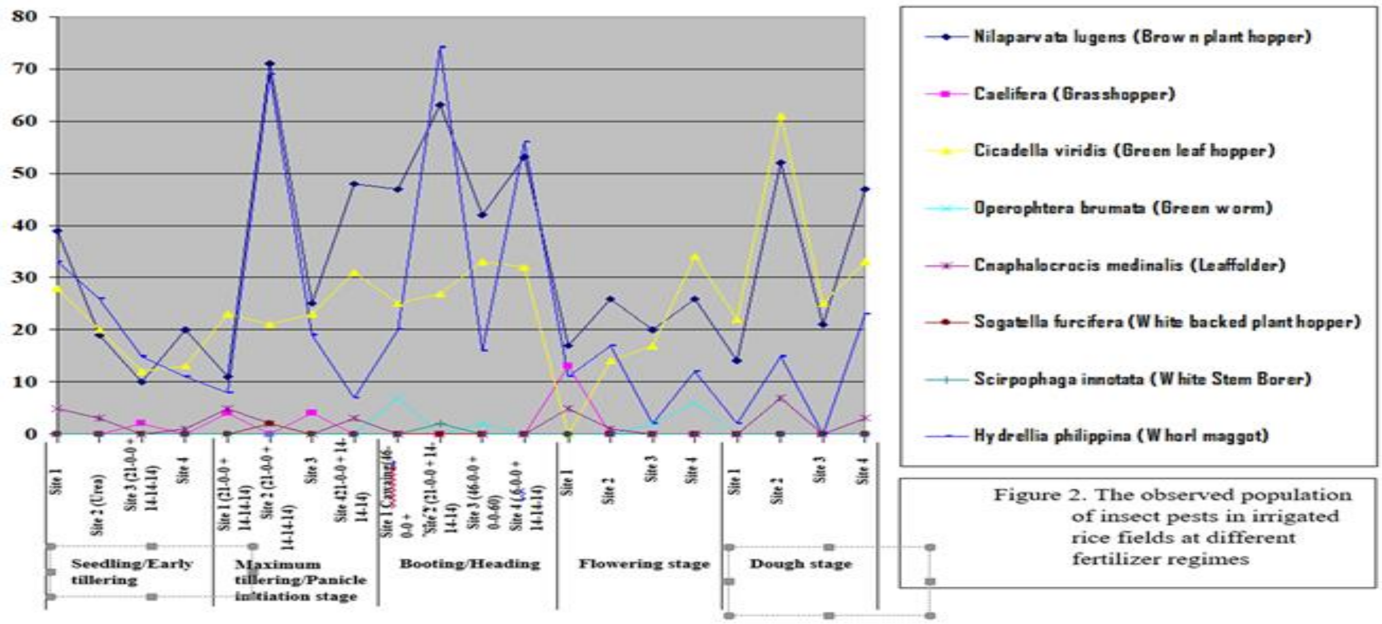

Fig 2. The observed population of insect pests in irrigated rice fields at different fertilizer regimes

Figure 2 below presents the estimated occurrence or population of pests in irrigated rice fields at different fertilizer regimes. Brown plant hopper, green leaf hopper, and whorl maggot are common pests in the four sampling sites. During the vegetative stages (15 to 30 days), it is observed that the number of pests grows along with the application of different fertilizers such as 21-0-0 (Ammonium sulfate), 14-14-14 (NPK or complete fertilizers), and 46-0-0 (UREA). Madhuri, G. et.al (2017) also said that only nitrogen produced a higher incidence of BPH. Such outcomes can also be credited to making rice plants more succulent (Aziz et.al 2018). Phosphorus is considered an important component for the growth of phytophagous insects because it helps in RNA synthesis, when phosphorous is limited, severe consequences on the fecundity, growth rate, body size, oviposition, and survivorship of plant herbivores can occur (Rashid et.al 2016). As shown in figure 2, site 2 was applied with higher amounts of nitrogen and found higher organic matter content across sites and soil K (table 2 & figure 2) but revealed a higher population of BPH, whorl maggot, and green leafhoppers which have a total population of 221, 201, and 143 respectively. However, it is also observed in site 4 which received lower nitrogen has also a higher population of BPH with a total population of 194, followed by green leaf hopper with a total of 143 and whorl maggot with 109. This might be due to lower potassium application. A deficiency of potassium in rice plants has been found to increase the population build-up of the white-backed plant hopper, Sogatella furcifera (Horváth) while the application of a high dose of potassium to rice plants decreased the population build-up of this insect. During the reproductive stages (45 to 60 days), some sampling sites' fertilizer applications (including 0-0-60 or Muriate Potash) remained evident. The occurrence of mostly occurring pests is linked to the application of several fertilizers.

Figure 3. below exposes the identified weeds in four irrigated rice fields. It is found that common weed species include Fimbristylis dichotoma (Bungot-bungot), Ludwigia octovalvis (Kahoy-kahoy), and Echinochloa glabrescens (Dawa-dawa). Extreme cases of Fimbristylis dichotoma are observed in sites 1 and 3. According to Bajwa et.al (2014), weeds show a variety of responses to different fertilizers under different tillage systems depending upon the rate and method of application. Fertilization alters soil fertility, thus affecting weed density, nutrient uptake, and biomass yield, which in turn affects species composition and biodiversity.

Fimbristylis dichotoma (Bungot-bungot) grows well on wet or most likely in irrigated rice fields which maintain a 3 to 5 cm water depth, especially during the reproductive stages of the rice plant in this type of ecosystem, is more favorable to Fimbristylis dichotoma (Bungot-bungot) to reproduce. Donayre et al. (2018), also reported that Echinocloa glabrescens is highly competitive especially when its seedlings grow with rice seedlings during transplanting or after direct seeding. The weed was also reported as an alternate food for rice bugs and rice black bugs in the absence of rice.

A. Soil Characteristics of Sampling Sites

Table 1. Presents the soil characteristics of four sampling sites in terms of pH, percent organic matter (% OM), Phosphorous (ppm), and Potassium (ppm).

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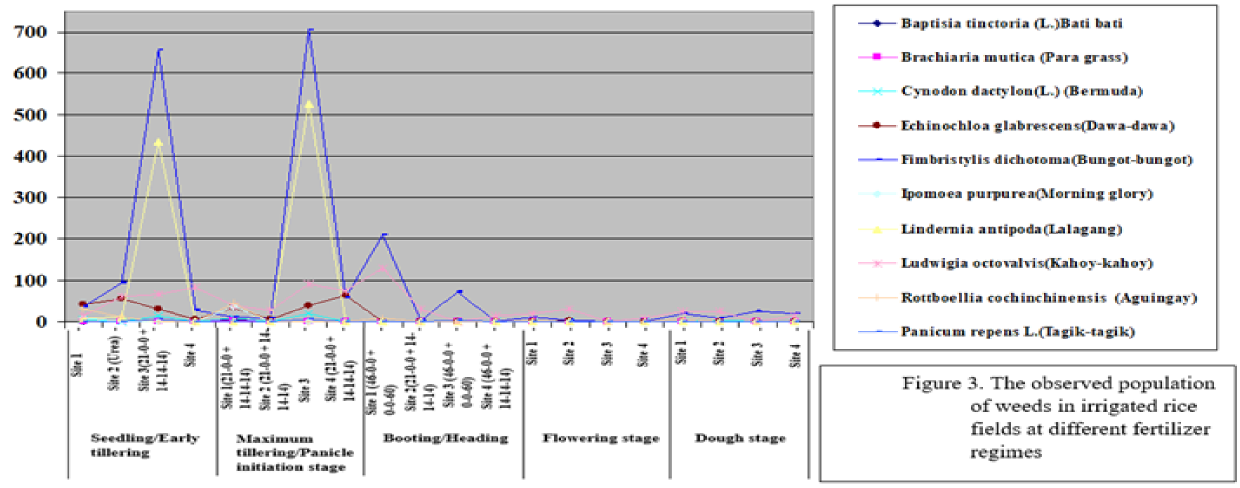

Fig 3. The obseved population of weeds in irrigated rice fields at different fertilizer regimes

The pH levels in all sampling sites fall within the acceptable range from 6.0-7.5 (Ilagan et.al. 2014). The suitable soil pH for rice cultivation is pH 6. This implies that most nutrients are available for most plants in the mentioned rice fields. Also, the study by Pham et al. (2018) revealed that most crops develop best in soil with a pH of 5.5 to 6.5. Soil pH affects nutrients available for plant growth. In highly acidic soil, aluminum and manganese can become more available and more toxic to plants while calcium, phosphorus, and magnesium are less available to the plant. In highly alkaline soil, phosphorus and most micronutrients become less available (Miller 2016). The percentage of organic matter (% OM) in soils ranged from 2.82 to 3.28 this shows that SOM across fields is in productivity levels. The largest % OM is found in site 2 while the least is revealed in site 1. According to Weil and Brady (2017), most productive agricultural soils have organic matter between 3 and 6% wherein the SOM of the four sites is in the acceptable range. Soil organic matter is the fraction of the soil that consists of plant or animal tissue in various stages of breakdown (decomposition). Soil organic matter is equally important to plants as it keeps and supplies nutrients essential to productivity, binds soil particles into aggregates, provides a habitat for soil organisms that stimulate nutrient cycling, and improves the water-holding capacity of the soil (Oldfield et al., 2019). Nutrient exchanges among soil, water, and organic matter are essential to soil fertility and need to be maintained for sustainable production purposes.

Phosphorous (P) and potassium (K) contents in ppm are also presented in Table 1. Ilagan et.al 2014 also reported, the range of 5-10 ppm indicates a medium level of available phosphorus whereas high available phosphorus is greater than 10 ppm. The beneficial availability of phosphorus in soil is within the soil pH of 6.8 (Shi et al., 2015). It is also noted that Soil Phosphorus across farms is within the desired value of 25 to 50 ppm. It can be gleaned from table 1 that the concentration of Phosphorous (P) is higher in site 1 (47.40 ppm) and site 3 (48.20 ppm) compared to the other two irrigated rice fields. In terms of potassium content, site 2 records the largest K content of 117.80 ppm and followed by Cawaing with 110.40 ppm. Available K (ppm) for rice ranges with values 20-80 ppm in which the four irrigated rice fields possessed a high level of soil K ranging from 98 ppm to 117.8 ppm although site 2 has the highest K content still he added K fertilizers to his farm. Ojha RB et.al (2021) stated that the availability of K in the soil is proportional to the added K fertilizer but a higher rate of K addition results in fixation rather than availability. As potassium is a so-called luxury consumption nutrient, additional K rates can sometimes result in loss. In addition, K is a mobile element and additional K results in leaching under flooded conditions in the case of rice cultivation.

Table 1. Soil Characteristics of Four Irrigated Rice Fields

Sampling Site	Mean							
	(pH)	SD	% (OM)	SD	P (ppm)	SD	K (ppm)	SD
1	6.55	0.08	2.82	0.19	47.4	3.51	110.4	11.78
2	6.45	0.21	3.28	0.36	25.4	1.8	117.8	11.8
3	6.43	0.22	2.84	0.41	48.2	6.53	99.8	18.82
4	6.56	0.11	3.2	0.31	23.4	2.7	98	6.36

Legend: SD - Standard Deviation; OM- Organic Matter; P- Phosphorus; K- Potassium

Table 2 below shows the concentration of nitrogen (N) and potassium (K) of rice crops in relation to pest occurrence. Data shows that N concentration is very low which ranges from 1.01 to 1.10 and K concentration is marginally ranging from 1.03 to 1. 26. It is shown that site 3 postulates the largest mean nitrogen concentration of 1.10. Along with the largest mean (N) concentration and second largest potassium (K) concentration that is recorded in site 3, it is also observed that occurrences of common pests such as Brown Plant Hopper (23.60), Green Leaf Hopper (22.00), and Whorl Maggot (10.40) are less dominant in the same farm. The other three sampling sites or rice fields unveiled a similar mean nitrogen concentration of 1.01. On the other note, site 1 has the largest potassium (K) concentration as evidenced by a mean score of 1.26 also shows fewer dominant pests which recorded 25.6 Brown plant hopper, 19.6 Green leaf hopper, and 14.8 Whorl maggot. While site 2 has the least mean potassium (K) concentration of only 1.03. Data showed that the farm received higher input of nitrogen and potassium fertilizers (Urea, ammosul, and muriate of potash) on the contrary, a lesser concentration of nitrogen (N) and potassium (K) was observed in site 2 where highly dominant pests' occurrences are found. Increasing levels of N and K application to rice plants resulted in a significant increase in N and K content in plant tissues but on the contrary, it showed lower concentrations of N and K (table 2). According to Ojha RB et.al (2021), the availability of K in the soil is proportional to the added K fertilizer but a higher rate of K addition results in fixation rather than availability. In addition, K mobile element and additional K results in leaching under flooded conditions in rice cultivation.

Table 2. N And K Concentration of Rice Crop in Relation to Pest Occurrence

Sampling Site	Mean				Pest		
	(N)	SD	(K)	SD	A	B	C
1	1.01	0.09	1.26	0.23	25.60	19.60	14.80
2	1.01	0.03	1.03	0.18	44.20	28.60	40.20
3	1.10	0.05	1.14	0.06	23.60	22.00	10.40
4	1.01	0.03	1.17	0.25	38.80	28.60	21.80

Legend: N- Nitrogen, K-Potassium, SD-Standard Deviation
Pest A- Brown Plant Hopper, Pest B-Green Leaf Hopper, Pest C-Whorl Maggot

Table 3 shows the correlation analysis results between the occurrences of pests and weeds against the soil characteristics and nutrient concentration. It can be gleaned that of all the pests presented, the brown plant hopper showed a positive and strong correlation with organic matter and a strong negative relationship with Phosphorous content as evidenced by the respective Pearson R values of 0.94 and -0.96. The incidence of BPH was directly proportional to applied

Table- 3 Correlation Analysis Between the Occurrence of Pests and Weeds Against Soil Characteristics

Incidence of Pests/Weeds	Statistics	Soil characteristics: pH	Organic Matter	P	K	Concentration: N	K
Brown plant hopper	Pearson R	0.04	0.94	-0.96	0.4	0.58	0.89
	P - Value	0.96	**0.01**	**0.04**	0.6	0.42	0.11
Green leaf hopper	Pearson R	-0.03	0.97	-0.97	0.07	-0.81	0.67
	P - Value	0.97	**0.03**	**0.03**	0.93	0.19	0.33
Lady beetle	Pearson R	-0.5	0.67	-0.51	0.8	-0.4	0.75
	P - Value	0.5	0.33	0.49	0.2	0.6	0.25
Leaf folder	Pearson R	0.45	0.23	-0.21	0.77	0.54	0.74
	P - Value	0.55	0.77	0.79	0.23	0.46	0.26
Whorl maggot	Pearson R	-0.18	0.87	-0.78	0.7	-0.43	0.93
	P - Value	0.82	0.13	0.22	0.3	0.57	0.07
Green Worn	Pearson R	0.76	-0.58	0.41	0.58	0.61	-0.49
	P - Value	0.24	0.42	0.59	0.42	0.39	0.51
Cynodon dactylon	Pearson R	-0.55	-0.79	0.84	-0.36	0.13	-0.9
	P - Value	0.45	0.21	0.16	0.65	0.87	0.1
Echinocloa glabrescens	Pearson R	0.68	-0.73	0.59	-0.33	0.83	-0.46
	P - Value	0.32	0.27	0.41	0.67	0.17	0.54
Fimbristylis dichotoma	Pearson R	-0.63	-0.64	0.69	-0.46	-0.1	-0.88
	P - Value	0.37	0.36	0.31	0.54	0.9	0.12
Lindernia antipoda	Pearson R	-0.68	-0.54	0.6	-0.47	-0.23	-0.84
	P - Value	0.32	0.46	0.4	0.53	0.77	0.16
Ludwigia octovalvis	Pearson R	0.88	-0.4	0.26	-0.1	0.82	-0.05
	P - Value	0.12	0.6	0.74	0.9	0.18	0.95
Rottboellia cochinchinensis	Pearson R	0.41	-0.64	0.62	0.33	0.97	-0.1
	P - Value	0.59	0.36	0.38	0.67	**0.01**	0.9

doses of nitrogen and inversely proportional to phosphorous. In the study of Singh et.al (2018) BPH population showed a positive correlation with nitrogen levels in plants and a conversely negative correlation with phosphorous. Likewise, the occurrence of green leaf hopper is similarly explained by the organic matter (Pearson R= 0.97) and Phosphorous content (Pearson R= -0.97). Further, concentration is evidenced by the Pearson R=0.97. The variability of the occurrences of other pests and weeds shows significant statistical relationships with other soil characteristics. Nitrogen remains the most limiting and important soil nutrient (Saito et al, 2019). Studies have also shown that increased N could enhance weed dry matter accumulation capable of competing with rice crops when weeding is delayed (Kolo et al, 2020, 2021).

IV. CONCLUSIONS

Pests and weeds are rising at the sampling sites which are contributory factors to the poor production of rice. Pests and weeds are significantly linked to fertilizer applications such as potassium (K) and nitrogen (N).

The soil characteristics such as soil pH and soil phosphorus (P) of the farm sites in RTRomualdez Agusan del Norte are in the normal range, and the content of organic matter (OM) is low.

However, soil potassium (K) is higher which is above the normal range when farmers applied more potassium fertilizers it may cause fixation rather than availability which aggravated further the occurrence of insect pests.

Rice crops have very low concentrations of nitrogen (N) and marginal levels of potassium (K). Rottboellia cochinchinensis (Aguingay) grows more with increasing N concentration.

The occurrence of pests is positively correlated to the organic matter and phosphorus (P) soil concentration. Further, nitrogen (N) is positively correlated to the occurrence of weeds. These implied that soil characteristics are significant factors in the occurrence of pests and weeds.

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