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Preface

We would like to present, with great pleasure, the inaugural volume-8, Issue-4, April 2022, of a scholarly journal, *International Journal of Environmental & Agriculture Research*. This journal is part of the AD Publications series *in the field of Environmental & Agriculture Research Development*, and is devoted to the gamut of Environmental & Agriculture issues, from theoretical aspects to application-dependent studies and the validation of emerging technologies.

This journal was envisioned and founded to represent the growing needs of Environmental & Agriculture as an emerging and increasingly vital field, now widely recognized as an integral part of scientific and technical investigations. Its mission is to become a voice of the Environmental & Agriculture community, addressing researchers and practitioners in below areas.

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Environmental science and regulation, Ecotoxicology, Environmental health issues, Atmosphere and climate, Terrestric ecosystems, Aquatic ecosystems, Energy and environment, Marine research, Biodiversity, Pharmaceuticals in the environment, Genetically modified organisms, Biotechnology, Risk assessment, Environment society, Agricultural engineering, Animal science, Agronomy, including plant science, theoretical production ecology, horticulture, plant, breeding, plant fertilization, soil science and all field related to Environmental Research.

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Agriculture, Biological engineering, including genetic engineering, microbiology, Environmental impacts of agriculture, forestry, Food science, Husbandry, Irrigation and water management, Land use, Waste management and all fields related to Agriculture.

Each article in this issue provides an example of a concrete industrial application or a case study of the presented methodology to amplify the impact of the contribution. We are very thankful to everybody within that community who supported the idea of creating a new Research with *IJOEAR*. We are certain that this issue will be followed by many others, reporting new developments in the Environment and Agriculture Research Science field. This issue would not have been possible without the great support of the Reviewer, Editorial Board members and also with our Advisory Board Members, and we would like to express our sincere thanks to all of them. We would also like to express our gratitude to the editorial staff of AD Publications, who supported us at every stage of the project. It is our hope that this fine collection of articles will be a valuable resource for *IJOEAR* readers and will stimulate further research into the vibrant area of Environmental & Agriculture Research.

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Assessment of Amakera spring water quality: A case study of Musanze district, Rwanda

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Abstract— *Water pollution from various types of pollutants is not only a serious environmental issue but also an economic and human health problem. This study investigated Amakera water springs located in Musanze District which is consumed by local people and tourists due to its taste. These springs take their source from underground aquifers. However, its quality is uncertain, therefore, its investigations come into prominence for its usability. Analysis of Physico-chemical and Bacteriological parameters to check its potable perspective in comparison with the international standard of drinking water was the main purpose. Samples were taken at three different sources in the dry season of 2020. In general, the results showed that the water is potable. Nevertheless, some parameters are present in high content especially dissolved salts which affect the taste of water and iron which affect the color of the river bed. The conductivity was found to vary from 8120µS/cm to 11,010 µS/cm while total hardness was found to be 637.50 mg/l as $CaCO_3$, 3,875.00mg/l as $CaCO_3$ and 1,852.50mg/l as $CaCO_3$ and TDS values were in the same range (3,800-3070mg/l), iron content were 8.90, 3.10, and 2.45 mg/l. The analysis indicated that all the three points are practically the same and can be consumed fresh. However, their protection is highly recommended to avoid the possible pollution.*

Keywords— Bacteriological, Physico-chemical parameters, pollution, Water quality.

I. INTRODUCTION

Water covers over 70% of the earth's surface and is the utmost valuable natural resource that exists on the earth [1,2]. Its world distribution indicates that only 2.5% and 97.5% constitute freshwater and saline water respectively [2]. Freshwater is indispensable in various domains of human daily life [3], moreover, it is generally seen as an essential input to human production and an effective tool of economic improvement [4]. Regrettably, in many countries around the world, including Rwanda, some drinking water supplies have become contaminated mainly due to both anthropogenic activities and natural processes [5,6] and the deteriorated quality of ground and surface waters is becoming a critical issue in many parts of the earth [1]. Water pollution from various types of contaminants is not only a serious environmental issue but also an economic and human health problem [7]. Many scientific techniques and tools have been developed to evaluate water contaminants [9,10,11]. These techniques include the analysis of different parameters such as pH, turbidity, conductivity, total suspended solids (TSS), total dissolved solids (TDS), total organic carbon (TOC), heavy metals, and microbes. These parameters can affect the drinking water quality if their values are in higher concentrations than the safe limits set by the East African Community and other regulatory bodies [8,11].

Freshwater sources in Rwanda exist as lakes, rivers, natural springs, and groundwater. The water supply for drinking purposes comes mainly from natural springs and underground water sources [18]. In this study, 3 water sources of Amakera Water namely Cyabararika, Rubindi and Kigombe were assessed. All these spring sources are located in Musanze District of Northern province of Rwanda. Cyabararika Cold Spring (site 1) takes its source from underground aquifers and was protected by the construction of delimitation walls many years ago to maintain its special quality, different from other surrounding water, unfortunately, they were damaged. This spring does not flow but instead, it is bubbling up from between two old constructed walls due to gases from underground [19]. The spring is surrounded by a small wetland alongside the Mpenge River and it is used for different human activities. Whereas, Rubindi Cold Spring (site 2) collects its water from three small springs which take their sources from Karisimbi volcano and meet to form a large spring. The water quality of Rubindi spring depends on the surrounding environment and human activities around the spring. The spring is surrounded by cultivated land and it flows between residences of people around there. Discharge from agricultural and residential areas may change the natural quality of the spring. Site 3, Kigombe water spring is also located in Musanze city, near horizon Sopyrwa factory. For all these springs, a large number of local populations fetch the water for drinking purposes. Many people like the taste of this water which is like "carbonated water" without being aware if it meets the drinking water standard, subsequently, its quality investigations come into prominence for its usability [10,19]. This study aimed at analyzing the Physico-chemical and Bacteriological parameters to check its potable perspective in comparison with the international standard of drinking water.

II. MATERIAL AND METHODS

2.1 Site description

This study was conducted in Northern part of Rwanda, Musanze district. The samples were taken in 3 sites as shown in Fig 1. Cyabararika Cold Spring (site 1) is a small spring located in Musanze city, alongside the Mpenge River. This spring takes its source from underground aquifers. Whereas, Rubindi Cold Spring (site 2) is located in Gataraga village of Musanze District in Northern Province about 8 km Northwest of Musanze town. This spring is located at the footstep of Karisimbi volcano in Virunga Volcanic Range 600 meters below the park boundary. Site 3, is also located in Musanze city, near horizon Sopyrwa factory.

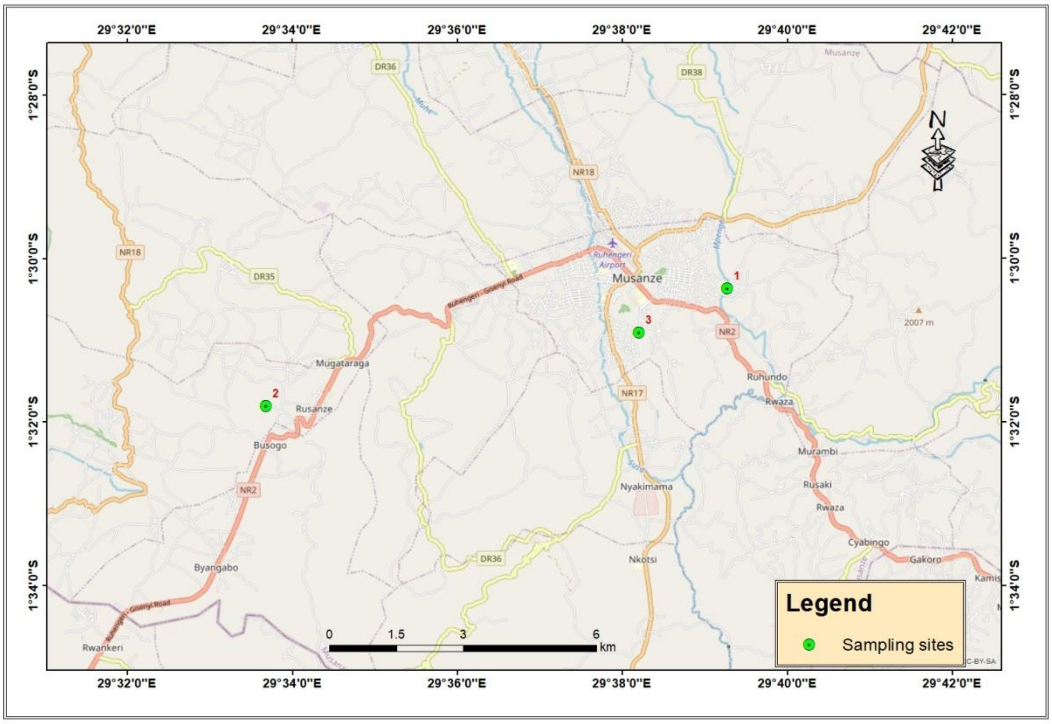

FIGURE 1: Sampling sites

2.2 Sampling and analysis

All samples were taken in well cleaned and identified bottles and were transported and kept at a low temperature of 4°C. Physico-chemical parameters (pH, temperature, and EC) were tested in situ using a high-accuracy multiparameter water quality meter called Bante instrument 900, TDS was analyzed using a TDS-meter (ST20T-B). The turbidity of water was measured in situ using a turbidity meter. Total suspended Solid (TSS) was measured after vacuum filtration using cellulose filters (0.45μm) and oven-dried at 105±1°C for 1hour. Total Hardness (TH) was determined by the EDTA titration method with eriochrome black T indicator. A spectrophotometer UV-Visible (Palintest 8000) with compatible kits was used to analyze anion SO_4^{2-}, nutrients (NO_3^-, NH_3 and PO_4^{3-}) while the iron content was determined using the Atomic Absorption Spectrometric method. Chloride was determined using a titrimetric method with silver nitrate and potassium chromate as an indicator. Enumeration of Escherichia Coli (E. Coli), Total Coliforms (TC) bacteria, and Faecal Coliform (FC) were done by membrane filtration method with corresponding culture media.

III. RESULTS AND DISCUSSION

3.1 Physico-chemical results

The results of Temperature, pH, Turbidity, TDS, EC, TSS, Nitrates, Phosphates, Sulphates, Ammonia, Chlorides, Iron, and Total hardness content of all the sampled sites were found to be within the acceptable limit as shown in Table 1.

TABLE 1
RESULTS OF PHYSICO-CHEMICAL PARAMETERS

Parameters	Unit	Amakera site 1	Amakera site 2	Amakera site 3	EAC (2018)
Temperature	^oC	19	18.2	18.2	
pH	-	5.2	6.78	6.82	5.5-9.5
Turbidity	NTU	0	0	0.98	5
TDS	Mg/L	3,800.00	3,070.00	3200	1500
EC	µS/Cm	11, 020.00	10,100.00	8120	2500
TSS	Mg/L	0	0.1	0.2	Not detectable
Nitrates	Mg/L	4	1.9	2.6	45
Phosphate	Mg/L	1.35	2	2.18	2.2
Sulphates	Mg/L	7	59	60	400
Ammonia	Mg/L	0.55	0.12	0.205	0.5
Chlorides	Mg/L	24.99	26.13	25.1	250
Iron	Mg/L	8.9	3.1	2.45	0.3
Total Hardness	Mg/L	637.5	3,875.00	1,852.50	600

pH: The pH was carried out and the values were ranged from 5.20 to 6.82, according to several organizations including RSB, EAC the potable water specification, pH acceptable limit ranges between 5.5 and 9.5 [11]. For this study, the pH of all sites were showing the acidic character where two sites fall in the normal range while the third one is slightly below the limit, which could be due to the contamination from the human activities around the area.

Electrical conductivity: The electrical conductivity is commonly used to indicate the total concentration of ionized constituents of water [12]. According to EAC (2018) standard, the acceptable limit for potable water is 2500 µS/cm [11]. The conductivity was found to be high for all samples varying from 8120µS/cm to 11,010 µS/cm, this might be due to high mineral content in water.

***Total Dissolved Solids (TDS)*:** Total dissolved solids describe the number of inorganic salts mainly salts of calcium, magnesium, sodium, among others, and the small percentage of organic matter present in the water [12]. In this study, TDS values were in the same range (3,800-3070mg/l) and above the permissible limit which is 1500mg/l [11]. This confirms with the EC values showing high inorganic salts content and the water may be saline. Total dissolved solids (TDS) level of less than about 600 mg/l is normally considered to be acceptable for drinking purpose, it becomes significantly and increasingly unpalatable at TDS levels greater than about 1500 mg/l which is the case for this study. The presence of high levels of TDS may cause unpleasant taste to consumers [11,12].

***Total Suspended Solids (TSS)*:** The EAC has set that TSS must not be detectable in potable water [11]. The TSS values of all water samples studied are shown in Table 1. The results showed that Amakera site 1 of the study area was within acceptable limit while Amakera site 2 and 3 were slightly above the permissible limit with 0.1 and 0.2mg/l TSS contents respectively. This could be due to the agricultural activities in the area and other anthropogenic activities.

Nitrates (NO_3^-): Nitrate in groundwater is generally of anthropogenic origin and associated with the leaching of nitrogen from agriculture plots. The EAC standard has set the maximum limit of 45mg/l [11]. During this study, the maximum value of nitrate was found to be 4.0mg/l which is within permissible limit for drinking water.

Phosphate: The phosphate content found were 2.18 mg/l, 2.00 mg/l, and 1.35 mg/l for Amakera site 3, site 2, and site 1 shown in table 1 respectively. They are all within the acceptable range [11].

Sulfate: The sulfate level of natural waters is a key factor in assessing their acceptability for public and industrial usage; a high sulfate concentration can cause respiratory difficulties in humans [13]. SO_4^{2-} was recorded as 7mg/l, 59mg/l and 60mg/l for site 1, 2 and 3 respectively. All the values obtained were below the maximum limit of 400mg/l as per EAC [11].

Ammonia: The acceptable limit of ammonia is 0.5mg/l as set by EAC potable water specification [11]. During this study, high ammonia content was found to be slightly above the acceptable value of 0.55mg/l for site 1, whereas the two remaining sites were within limit 0.12 and 0.205mg/l for site 2 and site 3 respectively. Ammonia contamination can arise from bacterial or bioorganic materials contamination [14].

Chloride: A high concentration of chlorides is regarded a pollution indicator because it causes a salty taste in drinking water and accelerates corrosion of water pipelines and irrigation water, which can harm agricultural products and produce foliar burns on crops when deposited on leaves [15]. Between the three sites, the chloride content indicated only minor differences in sampling points. The values found were 24.99 mg/l for site 1, 26.13 mg/l for site 2, and 25.1 for site 3. By comparison, all of the results were within the acceptable chloride limit defined by the EAC for drinking purposes, which is 250 mg/l [11].

Iron: The results found were high compared to the maximum defined by EAC standard, while the maximum value is 0.3 mg/l [11], the following values 8.90, 3.10, and 2.45 mg/l were found for site 1, 2, and 3 respectively. Iron is found in the form of iron (II) salts, which are unstable and precipitate as insoluble iron (III) hydroxide, which settles out as rust-colored silt, due to the high amount of iron-containing wastes or soil and rocks weathering and Staining of laundry and plumbing may occur at concentrations above 0.3 mg/l this agrees with the fact that Amakera water is not used in washing or cooking because they get colored [16]. Despite its high concentration, it does not have a negative health effect [16].

Total hardness: The main hardness-inflicting cations are particularly the divalent calcium, magnesium and occasionally strontium, ferrous iron, and manganous ions [13, 15]. Total hardness was found 637.50 mg/l as $CaCO_3$, 3,875.00mg/l as $CaCO_3$ and 1,852.50mg/l as $CaCO_3$ for site 1, 2 and 3 respectively. Hardness for all sites was high compared to the permissible limit; this might have caused an increased concentration of salts [15]. The hard water doesn't give lather with soap, this might be the reason the local people don't use Amakera for washing.

3.2 Bacteriological results

The results of the bacteriological analysis are represented in Table 2. All tested parameters were found to meet the requirements of drinking water therefore; drinking this water cannot cause water-borne diseases [11].

TABLE 2
RESULTS OF BACTERIOLOGICAL PARAMETERS

Parameters	Unit	Amakera site 1	Amakera site 2	Amakera site 3	EAC Limit
E.COLI in 100ml	CFU/100ml	0.00	Absent	Absent	Not detectable
Feacal coliform	CFU/ml	$2.3*10^{-3}$	0	0	Not detectable
T.Coliform in 100ml	CFU/100ml	0.00	Absent	Absent	Not detectable

IV. CONCLUSION

The purpose of this research was to assess the quality of Amakera water located in Musanze District. In general, the results showed that the water is potable. However, some elements are present in high content especially dissolved salts which affect the taste of water and iron which affect the color of the river bed. It was found also that this type of water is used fresh because of a high content of iron which gets oxidized with time.

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Integrated Weed Management (IWM) for Sustainable Agriculture – A Review

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Abstract— *Weeds are defined as any growing plant infield, where it is not wanted and weeds are also used as feed for the animals. Weeds are creating a big problem in agriculture by reducing the growth and development of crops and minimizing the yield of the crops. Weeds are the major problem in agriculture therefore management practices require increasing the yield of the crops. Sustainable agriculture is defined as a farming system that meets foods for the present population by reducing the use of chemicals. Integrated weed management (IWM) is defined as a process that synchronizes the use of major and minor information on the environment, ecology, and biology of weeds, and ecologically controlling the weeds from fields. Yield losses in soybean may range from 25 to 70 %, 40-80 % in onion, 40-70% in maize, 40-50% in rice, and 25-50% in wheat depending upon the intensity and infestation of weeds. Rice residues as mulching at 6 and 7 t/ha and adding post-emergence herbicides like clodinafop 60 g/ha, sulfosulfuron 25 g/ha, and mesosulfuron+iodosulfuron 14.4 g/ha were found more effective to control weeds like P. minor and also board leaf weeds from the wheat field. Zero tillage is generally done in wheat crops and also in maize crops to minimize of cost of cultivation. The incorporation of daincha and azolla in a field generally increases the yield of the crops during the early stages.*

Keywords— Integrated weed management (IWM), Losses, Components, and Herbicides.

I. INTRODUCTION

Integrated weed management (IWM) is a management system that's approach on required awareness of implementation on a crop for its good health. They view it as a series of interactions among several weed control components (Swanton *et al.* 2008). Integrated weed management (IWM) is the process that synchronizes the use of major and minor information of environment, ecology, and biology of weeds, and ecologically controlling the weeds from fields by using all available technology. Integrated weed management (IWM) research are focusing on the process of decision-making, ecology and biology of weeds, components of IWM which are generally practiced on cropping pattern, resistance level of herbicide, ecology problem related to transgenic plants, and weeds welfare (Rao and Nagamani, 2010). Integrated weed management (IWM) is defined as a collecting environmental information, ecology and biology of weeds using all available technology for controlling the weeds (Sanyal, 2008). IWM focuses on reduction of weeds in a single or multiple season and also use the broadcast-type equipment for controlling of weeds. In traditional methods, puddling is done for the killing of weeds and aid water retention and also for the transplanting of rice (Rao *et al*., 2007). From a biological approach, successfully integrating weed management requires an understanding of three key components: the effect of treatments on weed populations, weed growth and development stages and the critical period for applying control tools (Swanton *et al.*, 2008). Control tools (e.g. mowing, spraying, cultivating) have differing effects on weeds, and without a complete understanding of the life history of the target weed(s) and crop, the development of effective and efficient robotic systems will be extremely challenging, if not impossible. In all crops, there exists a period in which weed control is critical to avoid incurring yield loss (Knezevic *et al.*, 2002). Combining recognition and application technology into a single platform for fast and efficient weed control across spatiotemporal scales will require precise information on weed biology and ecology and continued testing of technology for a wide range of field conditions (Slaughter *et al.*, 2008; Singh *et al.*, 2011). Considering the diversity of weed problem and agro-ecosystems, no single method of weed control could reach the desired level of efficiency under all situations (Singh 2010). Thus, IWM has been suggested as a sustainable and long-term management technique.

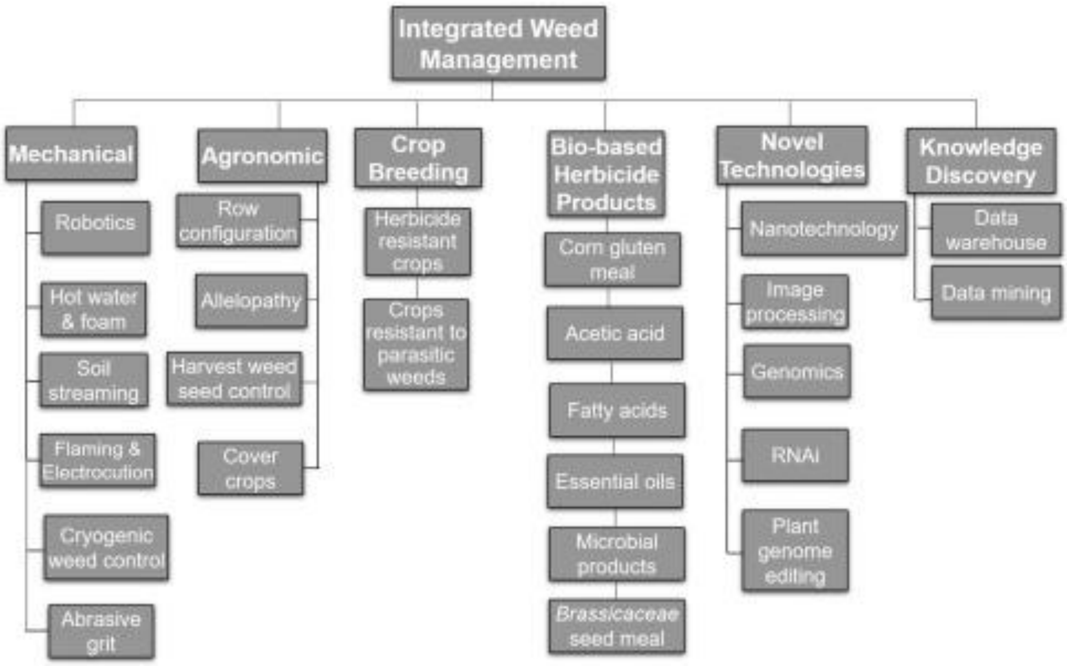

FIGURE 1: Components of Integrated weed Management (IWM)
Source: Nicholas et., al. 2019

II. YIELD LOSSES DUE TO WEED COMPETITION

In rice crops, about 350 weed species having 150 genera and 60 plant families are found as weeds, and more than 80 species of Gramineae are reported as weeds in a rice field. The most common weed species of rice are *Echinochloa crusgalis, E. colonum, Cyperus difformis, C. rotundus, C. iria, Eleusine indica, Fimbristylis miliacea, Ischaemum rugosum, Monochoria vaginalis, and Sphenoclea zeylanica.* The presence of these weeds species creates major problems in the rice field. Seeding method, soil moisture, crop rotation, air and soil temperature, land preparation, fertilization, rice cultivar, and weed control technology are the best methods for controlling weeds. The presence of weeds reduced the production of rice and as well as reduced the quality of the rice crop. Losses caused by weeds are influenced by competitive efficiency of weeds and rice, species or group of weed, weed density, duration of the weed-crop competition, planting method, cultivar, fertility level, water management, row spacing of the crop, allelopathy.

TABLE 1
MAJOR WEEDS WHICH ARE FOUND ON THE FIELD OF PULSES

Season	Type of weeds	Name of weeds
Kharif pulses	Non -grasses	*Digeraarvensis, Commelinabenghalensis, Celosia argentea, Cucumistrigonus, Trianthemamonogyna, Euphorbia hirta*
	Grasses	*Digitariasanguinalis, Cynodondactylon, Panicum sp. Echinochloacolonum, Dactylocteniumaegypticum, Setariaglauca, Eleusineindica*
	Sedge	*Cyperusrotundus*
Rabi pulses	Non -grasses	*Chenopodium album, Solanumnigrum, Anagallisarvensis, Vicia sativa, Fumariaparviflora, Asphodelustenuifolius, Convolvulus, Melilotusindica, Medicago denticulate*
	Grasses	*Phalaris minor, Avenaludoviciana*
	Sedges	*Cyperusrotundus*
Zaid/Summer pulses	Non-grasses	*Chenopodium album, Amaranthusviridis, Portlacaquadrifida, Trianthemamonogyna*
	Grasses	*Setariaglauca, Cynodondactylon, Eleusineindica, Digitariasanguinalis, Panicummaxicum*
	Sedges	*Cyperusrotundus*

Source: 25 Years of Pulses Research at IIPR

TABLE 2
CRITICAL PERIOD OF WEED COMPETITION FOR IMPORTANT CROPS.

S.N.	Crops	Days from sowing	S.N.	Crops	Days from sowing
1	Rice (lowland)	35	7	Cotton	35
2	Rice (upland)	60	8	Sugarcane	90
3	Sorghum	30	9	Groundnut	45
4	Finger millet	15	10	Soyabean	45
5	Pearl millet	35	11	Onion	60
6	Maize	30	12	Tomato	30

In India, presence of weeds in general reduces crop yields by 31.5 and 22.7% in winter season and 36.5% in summer and kharif season and in some cases can cause complete devastation of the crop (Anonymous, 2007). Yield losses in soybean may range from 25 to 70 percent depending upon the intensity and infestation of weeds. Besides yield losses, quality also adversely affected. The most critical period of weed infestation is initial 15-45 days (Kale, 1985). Weeds are major problems for crops cultivation its generally reduces the growth and development of the crops. In the field of onion, 40-80 %yield is reduced due to infestation of weeds (Channapagoudar and Biradar, 2007). The yield losses found highest at unweeded plots of the rice-wheat system, but it was lower at sugarcane system (Singh *et al*., 2005a). The prevention from yield losses should be done during crops growth cycle by reducing weeds from the field at critical period. Production losses may also occur due to weeds as 33.16% in food crops, 41.26% in cereals, 31.88% pulses, 40.82% in oilseeds, 34.23% in fibre crops and 40.28% in rice crops in the country. However, an average of 13.1% of crop produce is actually lost in the farmers field even after adopting traditional weed controls in Bangladesh.

TABLE 3
YIELD LOSSES DUE TO WEEDS IN MAJOR CROPS.

Crops	Reduction in yields due to weeds (%)	Crops	Reduction in yields due to weeds (%)
Rice	41.6	Groundnut	33.8
Wheat	16.0	Sugarcane	34.2
Millets	29.5	Sugar beet	70.3
Soyabean	30.5	Carrot	47.5
Gram	11.6	Cotton	72.5
Pea	32.9	Potato	20.1
Maize	39.8	Onion	68.0

Source: TNAU

The yield of grain was reduced by 25% to 47% and straw yield was reduced by 13% to 38% due to Crop weed competition. The infestation of weeds in a field reduced the content of soil nitrogen and phosphorus and also the pH level of the soil. The root, stem, and leaf of dominant weeds (Echinochloa colona, E. crus-galli, Cyperus iria, and Ageratum conyzoides) showed a weak effect on seeds germination however most of them had an inhibitory effect on root and shoot elongation of paddy seedlings. The weeds show more inhibition on the growth of paddy seedlings as compared to leaf and root.

TABLE 4
CRITICAL PERIOD OF CROP-WEED COMPETITION AND YIELD LOSSES DUE TO WEEDS IN PULSE CROPS.

Crops	Critical period (Days after Sowing)	Yield loss (%)
Pigeonpea	15-60	20-40
Mungbean	15-30	25-50
Urdbean	15-30	30-50
Cowpea	15-45	15-30
Chickpea	30-60	15-25
Fieldpes	30-45	20-30
Lentil	30-60	20-30
Frenchbean	30-60	15-30

Source: Yaduraju and Mishra (2004)

III. IWM WITH HERBICIDES AS A COMPONENT

Integrated weed management (IWM) is defined as using multiple methods for controlling weeds from the field with a combination of the most effective practices to control weeds. Prevention, Cultural, Mechanical, Chemical, and Biological are the practices used for Integrated weed management (IWM). A prevention method is defined as the equipment which is used in the field has contaminated with weed seeds. The primary spreaders of weeds are equipment, manure, feed, and crop seeds. The controlling of weeds should be done by cleaning all the equipment, which is used in crops field.

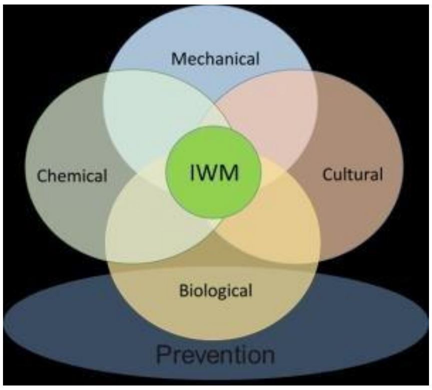

FIGURE 2: Management tactics used in integrated weed management (Annie Klodd)

The Cultural method is also used for controlling weeds and is found more effective as compared to chemicals. The crop management decisions help in controlling weeds and help in optimizing the effectiveness of chemical applications. Timely scouting, row spacing, crop rotation, crop variety selection, the timing of planting, and cover cropping are the best practices that are used for controlling weeds in the Cultural method. Cultivation, tillage, burning, Puddling, and hand-weeding are the practices of mechanical management of weeds. Emerging technologies like harvest-time seed destructors, cover crop rollers, and robotic weeders are also used in controlling weeds through the mechanical method. The use of living organisms, including livestock, insects, nematodes, fungi, and bacteria are used in the Biological method for controlling weeds from the crop field. The biological method is eco-friendly in controlling weeds.

TABLE 5
HERBICIDES USED FOR CONTROLLING WEED SPECIES AND THEIR TOXICITY LEVEL AND MODE OF ACTION.

Herbicide	Mode of action	Weeds controlled and use	Toxicity	Warnings
Buster	Systemic contact herbicide (via the leaf). No residual life in the soil.	Grasses, broadleaved weeds and clovers. Provides short-term weed control	Poison.	Avoid contact with desirable plants and immature bark.
Gallant NF	Emulsifiable concentrate. Half-life in the soil of less than 24 hours	Selectively controls grasses. Can be mixed with Versatil, Gardoprim or Simazine for controlling clovers and broadleaved weeds.	Harmful substance.	Immediately after use, flush sprayer several times with clean water.
Glyphosate Roundup, Renew	Absorbed through foliage and translocated to all parts of the plant, including roots. Half-life <14 days in aerobic soil, and 14-22 days in anaerobic conditions.	Controls most annual and perennial grasses and broadleaved weeds. Used as a pre-planting or a release spray. Can be used successfully as a stump poison.	Low toxicity.	Spray drift must not contact foliage or green-bark of desirable trees.
Interceptor (Organic spray - new product with limited information on weed control in establishing native plants)	Emulsifiable, non-selective, contact foliage spray. Penetrates green plant tissue, and disrupts cellular physiology. Fast acting (within minutes) but may require additional treatment.	Controls annual weeds and grasses, and perennial weeds. Can be used as a pre-planting or release spray.	Low toxicity.	Spray drift may damage foliage, fruit or unprotected green bark of desirable plants. Also kills algae, mosses and liverworts.
Simazine	Absorbed only through roots of germinating plants. Soil residual life ranges from 3 - 12 months. Half-life varies from 27-102 days. Low leaching potential.	Prevents the emergence of a wide range of annual and perennial grasses and broadleaved weeds.	FlowableSimazine - poison. Others - low toxcicity.	Spray drift may cause serious damage to other plants.
erbuthylazine (Gardoprim)	Absorbed through roots and leaves. Pre- and post-emergent half-life in biologically active soils is 30 - 60 days.	Controls a wide range of annual and perennial grasses and broadleaf weeds. Apply pre-planting or as a release.	Hazardous substance	Follow manufacturers recommendations. Avoid using near desirable plants, where the chemical may be leached into their root region.
Versatil	Absorbed by leaves, stems and roots.	Controls thistles, yarrow, clovers and many difficult flat weeds. Can be mixed with other herbicides for the control of additional weeds. Do not apply to legumes or compositae (daisy family)	Harmful substance.	Follow manufacturer's recommendations. Remains active on plant material - do not use clippings from treated areas for compost or mulch, within 6 months of treatment.

Source: Department of Conservation

IWM found more effective when use of herbicides with following components. Which are given below:-

3.1 Crop Rotations, Cropping Systems and Herbicides

The crop rotation is defined as a cultivation of crops in specified order on the field for reducing weeds competations and increasing the yield of crops. And the cropping system is generally known as cropping pattern which minimize yield losses and provide better environmental conditions to the crops. Crop rotation and cropping systems both are component of IWM. The different cropping sequences failed to affect broadleaf weeds. Rice-lentil+mustard (3 : 1)-cowpea, rice-maize + pea (1 : 1)-cowpea and rice-potato-greengram gave high yield (Singh *et al*., 2008).

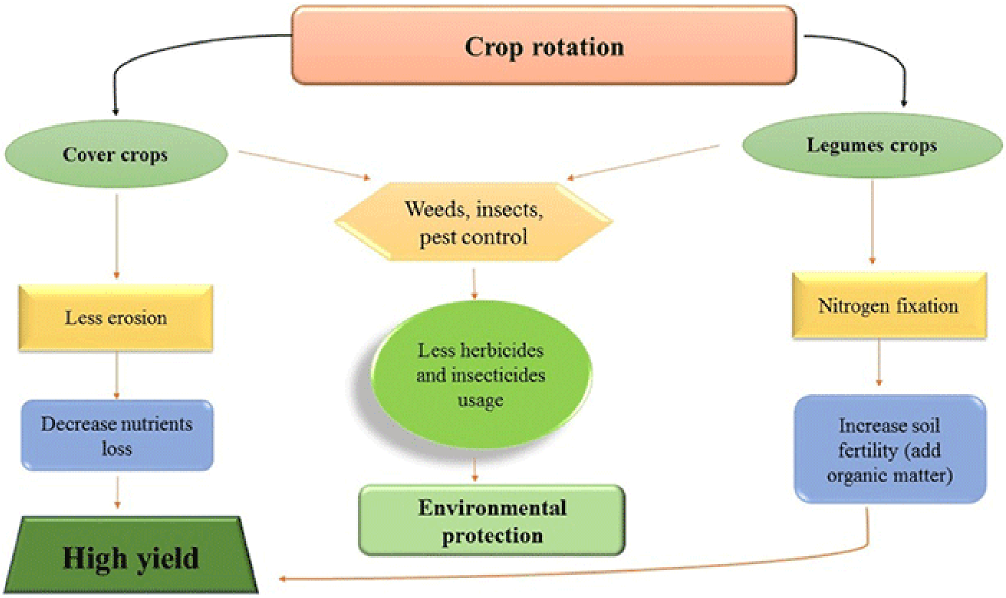

FIGURE 3

Source: Faisal Nadeem and Ahmad Nawaz et. al.

The reduction of weed density and dry weight of the field was achieved by effective weed control and intercropping with *Sesbania* (Dhaincha), and azolla with pretilachlor and safener at 400 g/ha found control against weeds (Subramanian and Martin, 2006). The incorporation of daincha and azolla in field generally increases the yield of the crops during early stages. The cropping sequence of mungbean-mustard giver higher yield (Singh, 2006).

TABLE 6
HERBICIDES WHICH ARE USED IN CROPPING SYSTEM FOUND BETTER WEED CONTROL.

Cropping System	Herbicides	Dose (kg ai/ha)	Trade Name & formulation	Time of application
Sorghum + Cowpea	Pendimethalin	0.90	Stomp 30% EC	Pre-emergence
Sugarcane + Pulses	Thiobencarb	1.25	Saturn 50% EC	Pre-emergence
Maize + Soybean	Pendimethalin	1.00	Stomp 30% EC	Pre-emergence

3.2 Tillage with Herbicides

Tillage is the best practice for the eradication of weeds from the field. The seeds of weeds are present in the fields and moving from field to field through tractor tires, and vegetative structures. The cultivation equipment like tractors and harvesters are moves seeds of weeds from field to field. The seeds of weeds are present in the depth of soil so tillage is used to remove weeds seeds from the field. In wheat cultivation, deep/inverted tillage with mouldboard plough and application of clodinafop @ 60 g/ha, sulfosulfuron @ 25 g/ha, and fenoxaprop ethyl @ 100 g/ha at post-emergence found effective control against *P. minor* (Walia *et al*., 2005).

TABLE 7
COMMON HERBICIDES USED FOR CONTROLLING WEEDS IN VEGETABLES AND FRUITS CROPS.

Chemical	Vegetables appearing on label	Weeds controlled	Timing of Application	Application rates
Burndown				
Glyphosate Trade name: Roundup®, other	Many crops; see label for specifics.	A non-selective herbicide that controls many weeds.	Pre-plant applications allowed in most plants. Post-directed and spot spray treatments are allowed for certain crops as long as care is taken to avoid contact with any foliage or green tissue. Consult label product labels for more specific information. Glyphosate has no soil residual activity	1 to 5 pints/acre or 1 to 10% solutions, depending on the crop Surfactant requirements are based upon formulation of glyphosate selected. Please consult label for specific recommendations.
Pelargonicacid Trade name: Scythe®, other	Asparagus, artichoke, beet, carrot, parsnip, potato, radish, sweet potato/ yam, turnip, rutabaga, garlic, onion, leek, shallot, celery, cilantrol, cress, endive, lettuce, parsley, rhubarb, spinach, broccoli, Brussels sprouts, cabbage, cauliflower, collards, kale, kohlrabi, greens (mustard and turnip), eggplant, okra, pepper (chili, bell, sweet), pimento, tomato, cucumber, gourd, muskmelon, cantaloupe, pumpkin, squash, watermelon, apple, pear, apricot, cherry, nectarine, peach, plum, prune, blackberry, blueberry, dewberry, grape, strawberry, grape and other fruits and vegetables	A non-selective herbicide that controls many weeds.	Post-directed (avoiding spray on foliage or green bark) and preplant applications in all landscape trees, bedding plants, flowers and other ornamentals. Pelargonic acid has no soil residual activity.	3 to 10% solution (spot spray): 3-5%-solution for annual weeds 5-7%-solution for perennial weeds 8-10%- Solution for maximum burn down of mature weeds No additional adjuvant required.
Pre-emergence				
Trifluralin Trade name: Preen™ Garden Weed Preventer	Many vegetable crops and non-bearing tree fruit and nuts *Not labeled for preemergence applications in cucurbit crops.	Several annual grasses, carpetweed, chickweed, Florida pusley, goosefoot, henbit, knotweed, lambsquarters, pigweed species, purslane	Pre-emergence weed control when applied to garden vegetables 2 to 3 inches tall but before weeds have emerged. However, application methods may differ with specific crops. This product needs immediate incorporation	1 lb / 400 sqft for heavy clay soils 1 lb / 960 sqft for medium loam soils 1 lb / 1280 sqft for light sandy soils

TrifluralinTrade name: Treflan® 4L, Treflan® EC, etc.	Many vegetable crops and non-bearing tree fruit and nuts *Not labeled for preemergence applications in cucurbit crops.	Several annual grasses, carpetweed, chickweed, Florida pusley, goosefoot, henbit, knotweed, lambsquarters, pigweed species, purslane	after application with irrigation, rainfall or light tillage. May be applied prior to planting or transplanting most vegetable crops. Immediate incorporation is necessary for optimal control. See label for more details.	1 to 2 pints/acre depending on crop and soil type (fine textured soils require the highest recommended rate, while coarse-textured soils require the lowest recommended rate)
Pendimethalin Trade Name: Prowl® H20	Carrots, sweet corn, edible beans, garlic, grain sorghum, lentils, mints, onions, peas, potato, sunflower and other vegetables	Several annual grasses, carpetweed, chickweed, Florida pusley, henbit, ladysthumb, common lambsquarters, pigweed species, purslane, spurge	Pre-plant incorporated or preemergence applications prior to planting or transplanting vegetable crops. Postemergence applications can be made in certain crops but weed control is dependent on applying prior to weed emergence.	1.5 to 4 pints/acre depending on crop and soil type (fine-textured soils require the highest recommended rate, while coarse-textured soils require the lowest recommended rate)
DCPA Trade name: Dacthal®, other	Broccoli, Brussels sprouts, cabbage, cauliflower, all Brassica leafy vegetables, cantaloupe/honeydew/watermelons (not preemergence but 3- to 5-leaf; do not incorporate), onions, radish (from preemergence up to 3-leaf stage), sweet potato, strawberry, tomato/tomatillos/ eggplant (4 to 6 weeks after transplanting or 4 to 6 inch tall seedling)	Several annual grasses, lambsquarters, carpetweed, chickweed, purslane, field pansy and suppression of other broadleaf weeds	Pre-plant or preemergence weed control	6 to 14 pints/acre or 4 to 5 floz/1 to 2 gallons (treats 1000 sq ft.
Post-emergence				
Sethoxydim Trade name: Poast®, other	apricot, asparagus, beans (dry, succulent), beets, broccoli, Brussels sprouts, cabbage, cauliflower, collards, garlic, kale, kohlrabi, leeks, mustard/ rape greens, cantaloupe, cucumber, honeydew, musk melon, pumpkins, watermelons, onions, radish, sweet potato, carrot, cherries, strawberry, grape, peppers, celery, lettuce, rhubarb,	Provides selective postemergence contact control of several grass species including, but not limited to, bermudagrass, broadleaf signalgrass, crabgrass spp., foxtail spp., goosegrass and johnsongrass.	Provides selective postemergence contact grass control only. Sethoxydim has little to no soil residual activity	1.5 to 2.5 pints/acre (depending on crop) Add 1% v/v crop oil concentrate.

	groundcherry, tomato, tomatillos, eggplant, raspberry, blackberry, lettuce, endive, parsley, spinach, mint, nectarine, peach, peanut, potato, plum apples, pears, peas (dry, succulent), artichoke, yam and other vegetables			
ClethodimTrade name: SelectMax®, other	Bean (dry), broccoli, cabbage, carrot, cauliflower (other head and stem Brassica), celery, cucumber, eggplant (other fruiting vegetables), garden beet, garlic, legume vegetables (garden podded), lettuce, melons (including cantaloupe and watermelon), mint, mustard greens, onion, pea, peanut, peppers, potato, pumpkin, radish, rhubarb, squash, strawberry, sunflower, sweet potato, turnip greens, tomato, yam (other tuberous and corm vegetables) and other vegetables	Provides selective post-emergence contact control of several grass species including but not limited to bermudagrass, broadleaf signalgrass, crabgrass spp., foxtail spp. and johnsongrass. Does not always adequately control goosegrass.	Provides selective post-emergence contact grass control only. Clethodim has little to no soil residual activity.	Annual grass weeds: 9 to 16 floz/acre Perennial grass weeds: 12 to 16 floz/acre Add 0.25% v/v nonionic surfactant.
Halosulfuron Trade name: Sandea®, other	asparagus, pumpkins, cucumbers, cantaloupes, honeydews, crenshaw melons, watermelons, winter squash, dry beans, succulent snapbeans, tomatoes, sweet corn and other vegetables	Cocklebur, common/ giant ragweed, galinsoga, hemp sesbania, kyllinga spp., ladsythumb/ smartweed, prickly sida, redroot pigweed, sunflower, velvetleaf, Venice mallow, wild radish, wild mustard and yellow/ purple nutsedge.	Provides selective post-emergence systemic control. Pre-emergence control may be less consistent.	½ to 1 1/3 oz/acre, depending on crop Add 0.25% v/v nonionic surfactant
BentazonTrade name: Basagran®, other	dry/succulent beans, dry/succulent peas, peanuts, corn, spearmint, peppermint and sorghum	Cocklebur, common purslane, eclipta, hairy nightshade, hemp sesbania, jimsonweed, ladysthumb/ smartweed, mayweed, morningglory, velvetleaf, Venice mallow, wild sunflower and yellow nutsedge.	Provides selective post-emergene contact control. Bentazon has no soil residual activity	1 to 2 pints/acre or 0.375 to 0.75 floz/1000 sqft Spot spray: 0.75 floz per 1 to 2 gallons of water Add 1% v/v crop oil concentrate
Organic Burndown				
Clove oil - active ingredient: eugenol Trade name: Matratec™, other	All fruit, nut and vegetable crops.	Many weeds, nonselective herbicide	Herbicide for organic production that provides non-selective post-emergence contact desiccation of several broadleaf and grass weeds. Post-directed (avoiding spray	5 to 8% solution (spot spray): 5% solution- broadleaf and grass weeds 6 inches in height, temperature below 60° F and cloudy 8% solution - grasses >6 inches in height, temperature below

			on foliage or green bark of crops) and pre-plant applications. Clove oil has no soil residual activity.	60° F and cloudy A non-synthetic adjuvant approved for certified organic crops may be added for improved performance.
Vinegar - active ingredient: acetic acid	All vegetable crops.	Certain broadleaf weeds with grass suppression	Organic post-directed (avoiding spray on foliage or green bark of crops) contact control. Vinegar has no soil residual activity.	At least a 20% solution for the most consistent performance. Multiple applications are often needed for long-term control.
Boiling water (~212°F)	All vegetable crops.	Many weeds	Organic post-directed (avoiding contacting foliage or green bark of crops).	Pour until plant foliage becomes wilted. Multiple applications are often needed for long-term control.

Source: The University of Tennessee, Institute of Agriculture.

**** Organic weed control products listed here can cause human harm such as chemical or heat related burns, if used improperly.***

3.3 Integration of Crop Competitiveness with Herbicides

Integration of Crop Competitiveness like, cultivation of Gautam as high yielding variety, and Prabhat as a weed minimizer variety of rice and adding herbicides like, butachlor @ 1.5 kg/ha at pre-emergence +2,4-D @ 0.5 kg/ha at post emergence found more yield as compare to others (Singh *et al*., 2004). Interaction of bidirectional row orientation in wheat, sowing with 120 kg/ha seeds with 15 cm or 20 cm row spacing and adding isoproturon @ 0.75 kg/ha found better minimization of weeds and provide higher yield of wheat (Angiras and Sharma, 1993).

3.4 Integration of Herbicides with Mulching

Herbicides are used for controlling weeds from the field but they do not effectively control the weeds. The use of crop residues as mulch in the time of weed emergence but only much can not control the weeds of the field. Therefore integrated use of herbicides and much could provide effective control of weeds. The integrated use of herbicide and much also increase the yield of the crop and control the weeds in dry-seeded rice. Mulch is a protective covering of material maintained on the soil surface. Mulching has a smothering effect on weed control by excluding light from the photosynthetic portions of a plant and thus inhibiting the top growth. It is very effective against annual weeds and some perennial weeds like Cynodon dactylon. Mulching is done with dry or green crop residues, plastic sheets, or polythene film. To be effective the mulch should be thick enough to prevent light transmission and eliminate photosynthesis. Paddy straw mulch @ 6 t/ha and adding herbicides like clodinafob and metribuzin @ 195g/ha at the time of post-emergence found the highest yield in the tuber of potato and effective weed control (Shafiq and Kaur, 2021). In the cropping system of rice/wheat, the placement of rice residues as mulching at 6 and 7 t/ha and adding post-emergence herbicides like clodinafop 60 g/ha, sulfosulfuron 25 g/ha, and mesosulfuron+iodosulfuron 14.4 g/ha found more effective to control weeds like *P. minor* and also board leaf weeds (Brar and Walia, 2008). Application of metribuzin or atrazine @ 1.0 kg/ha at the time of pre-emergence and mulching into Intra row trash at 3.5 t/ha, 60 days after planting found effective weeds control on the field of sugarcane (Singh *et al*., 2001). The economic cost of mulching is found more in the high-value horticultural crops. The use of black or white polyethylene sheets for mulching in ber, and adding one hand weeding at 70 days after sowing of bed nursery of ber found more effective weed control against *Cyperus rotundu.* In the ber orchard, application of glyphosate at 0.75, 1.0, and 1.5% found a reduction of *C. rotundus* from the ber orchard respectively 77, 85, and 95% (Yadav *et al*., 1996).

3.5 Integration of Zero Tillage with Herbicides

Zero tillage is generally done in wheat crops and also in maize crops to minimize of cost of cultivation. In zero tillage seeds are sown on standing stubbles of rice. *P. minor* is a major weed of wheat it uptakes the nutrient from the field which was provided for the wheat (Brar and Walia, 2007a). Sulfosulfuron+metsulfuron 15+4 g/ha, sulfosulfuron+triasulfuron 15+30 and 15+40 g/ha, and metsulfuron+triasulfuron 3+30 g/ha proved better against all weeds under zero tillage (Malik *et al*., 2007). Zero tillage (ZT) as part of a Conservation Agriculture based Sustainable intensification (CASI) package has been one strongly researched and promoted a set of practices to achieve sustainable agricultural intensification. Conservation Agriculture based Sustainable intensification focuses on changed tillage management practices for controlling weeds with zero tillage, crop residue, crop diversification, and use of herbicides (Brown et al., 2018).

3.6 Integration of Hand Weeding with Herbicides

Hand-weeding is a practice of controlling weeding on small farms because it is time-consuming, expensive, and required more labour. Hand weeding is the oldest method for controlling weeds by using an implement known as Khurpi. Hand weeding is more effective for controlling pollution in the field, water, and also in the air requires less herbicide to control the weeds. (Nagar *et al*., 2009) have proved that the integration of herbicides with hand weeding is the most effective and economical method of weed management. In vegetable crops application of pendimethalin 3.3 l/ha or Fluchloralin at 2 lit/ha or metolachlor 2 l/ha as pre-emergence herbicide with one hand weeding 30 days after transplanting was found to best control weeds.

TABLE 8
APPLICATION OF HERBICIDES AS PRE-EMERGENCE WITH ONE HAND WEEDING FOUND BETTER CONTROL OF WEEDS ON MAJOR CROPS

S.N.	Crops	Herbicides	One hand weeding (days after sowing)
1	Rice	Butachlor 2.5 l/ha or Thiobencarb 2.5 l/ha or Fluchoralin 2 l/ha or Pendimethalin 3 l/ha or Anilofos 1.25 l/ha as pre-emergence application.	30-35
2	Wet seeded rice	Pretilachlor + safener at 0.6 l/ha as Pre-emergence application.	40
3	Sorghum	Atrazine 50% WP 500 g/ha as Pre-emergence application.	30-35
4	Cumbu	Atrazine 50 WP 500 g/ha on 3rd day of sowing.	30-35
5	Maize	Atrazine 50 at 500 g/ha (900 lit of water) as Pre-emergence application.	40-45
6	Wheat	Isoproturon 800 g/ha as pre-emergence application.	35
7	Redgram, Blackgram, Greengram, Cowpea &Bengalgram	Fluchloralin 1.5 l/ha or Pendimethalin 2 l/ha 3 days after sowing mixed with 900 l of water.	30-35
8	Soyabean	Pendimethalin 3.3 l/ha	30
9	Groundnut	Fluchloralin at 2.0 l/ha	35-40
10	Cotton	Fluchloralin 2.2 l/ha or Pendimethalin 3.3 l/ha	35-40
11	Rice fallow cotton	Fluchloralin 2.2 l/ha or Pendimethalin 3.3 l/ha	40-45

IV. CONCLUSIONS

Weeds are creating a big problem for growing crops, they reduce production and caused huge economic yield loss of crops. So therefore management of weeds is important for increasing the production of crops and their value. Integrated weed management (IWM) is the best way to control weeds and it's also eco-friendly. Cultural, agronomical, mechanical, chemical, and biological is the methods that are used for controlling weeds. Mainly herbicides are used for controlling weeds but herbicides are very harmful to both humans and plants. The biological method is the best way to control weeds from the field and it's also nonharmful for humans, animals, and plants. Tillage and puddling are used for the removal of weeds seeds from the infested field. Mulching is knowns as leaving of crop residues or plastic for controlling weeds infestation in the crops fields. In Nepal and India mostly herbicides are used for controlling weeds because other practices are more costly as compared to herbicides. Biological weeds control methods are generally used in organic farming to find organic food from the crops field. Using herbicides to control weeds creates a big problem for a growing population. Herbicides are not good for human and plant health so other practices like cultural, mechanical, agronomical, and biological methods are used for the control of weeds are best for human and plant health. cultural, mechanical, agronomical, and biological methods for controlling weeds are also ecofriendly and give the best performance to control the weeds from the fields.

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Effect of Drought Stress on Initial Growth of Five Sugarcane Clones in Peat Media

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Abstract— *Sugarcane development on peatlands is constrained by drought conditions when entering the dry season, especially when climate anomalies occur, the dry season period becomes longer, as a result the number of tillers decreases and growth is not optimal. Planting drought stress-tolerant sugarcane clones through growth indicators is one solution to obtain clones that have the potential to be cultivated on peatlands. The use of drought tolerant clones is more profitable in the long term. The results of this study showed that the availability of media water and sugarcane clones had a significant effect on sugarcane plant height at early growth, but did not affect to the number of leaves and number of tillers. Sugarcane stem diameter at initial growth was influenced by a combination of media water availability and five sugarcane clones. PS881 is a clone that can adapt to drought stress conditions in peat media based on growth indicators of plant height, stem diameter and number of leaves.*

***Keywords—* peat, clone, drought, growth, sugarcane.**

I. INTRODUCTION

Sugarcane is a plant that has the potential to be cultivated in West Kalimantan to fulfill sugar needs. In 2018, the average sugarcane production in Kalimantan was 410 kg/ha/year. This means that sugarcane has the potential to be developed in West Kalimantan as support for the government to achieve sugar self-sufficiency in 2024. According to [1] the Kalimantan area is one of the suitable areas for sugarcane production by taking into account the water deficit and harvest time. Efforts to increase sugarcane development can be carried out on sub-optimal land on peatlands with the application of appropriate technology and processing systems [2]. However, drought conditions often occur when entering the dry season due to increasingly limited water supply and climatic anomalies that result in a longer dry season, as a result, plants are stressed in conditions of water shortages so that they cannot grow and develop optimally. Even though the availability of adaptive clones on sub-optimal land is still limited and becomes a problem in the development of sugarcane on peatlands. Drought stress is a limiting factor in the early growth phase of tiller formation [3]. In the vegetative phase, lack of water causes a decrease in the number of tillers, stem elongation which ends in a decrease in sugar yield because in the vegetative phase there is a process of cell division, cell elongation, and the initial stage of cell differentiation which will develop stems, leaves and root systems which will later be used for produce sugar yield.

One strategy to solve the problem of drought is by planting sugarcane clones tolerant of drought stress through growth indicators for several sugarcane clones that have the potential to be cultivated on peatlands. The use of drought tolerant clones is more profitable in the long term. Plants can grow in conditions of stress by adapting to develop their morphological and physiological processes. [4] Resulted plants experiencing drought conditions will survive by reducing CO_2 assimilation by 66% and their transpiration through stomata closure and will increase or recover after irrigation. One of the drought tolerance of sugarcane clones is determined based on its growth.

Research conducted by [5] using five sugarcane clones resulted that the PS881 clone and PS864 clone regression test resulted in a regression coefficient of less than one, which means that both clones can adapt to a less than optimal environment. PS881 clone planted on dry land vertisol soil with a spacing of 30 cm x 100 cm with single bud planting material produced the best productivity [6]. [7] Showed that the initial growth of sugarcane plants can run optimally if the water capacity in the soil is at least 50% and at least 80% in the stem elongation phase. If the soil water content decreases to 40% (suboptimal) it can reduce 50% of the number of tillers formed at 2-4 BST and at 100% optimal soil water content or in a state of field capacity the number of tillers increases from 5.04 tillers/polybag to 7 ,33 tillers/ polybag.

The purpose of this study was to determine the effect and interaction of water availability in media and sugarcane clones on early growth of sugarcane on peat media and clones that are resistant to drought stress in peat media based on growth indicators. Research on the resistance of sugarcane clones to drought stress through growth indicators can be used as a basis for starting sugarcane cultivation on peatlands during the dry season and developing further research.

II. RESEARCH METHODS

The research was carried out at the Greenhouse and Plantation Plant Science Laboratory, Pontianak State Polytechnic, West Kalimantan for 5 months.

2.1 Materials and Equipment

The materials used were peat soil, dolomite, cow manure compost, fungicide, six sugarcane budchip clones, polybags. The equipment used were soil sieve, hoe, ruler, thermometer, test tube, Erlenmeyer, beaker glass, stirrer, microscope, preparations, clear nail polish, 21D spectrometer, analytical balance.

2.2 Research Implementation

2.2.1 Budchip Germination

The planting material used was five sugarcane budchip clones. The budchips are first soaked in water at a temperature of 50°C for 15 minutes [8] followed by fungicide immersion, after which the budchips are germinated in plastic in a dark room until shoots appear. After that, it is sown using a nursery tray containing peat soil that has been mixed with compost evenly, then maintenance is carried out until the age of 2 weeks [9].

2.2.2 Making Planting Media

The planting medium used is peat soil with saprik maturity. The media was made by mixing evenly the sifted peat soil with cow manure compost in a ratio of 1:1, then added dolomite until the pH reached 6-7. The processed media was put into polybags measuring 30 cm x 30 cm and incubated for one week.

2.2.3 Planting

Budchips that have been sown and have grown into perfect seeds are selected and selected field capacity seeds, free from plant-disturbing organisms. Planting is done in one polybag with one planting hole filled with 1 sugar cane seed. The environmental design used in this research is the Split Plot Design which consists of two factors, namely the first factor is the availability of media water (field capacity/100% and 40% drought stress) which is used as the main plot and the second factor is 5 Sugarcane clones (NX01, BM1612, PS881, BM1617, Local) used as sub-plots. The treatment was repeated 3 times and each replication contained 3 samples.

2.2.4 Drought Stress Treatment Application

Drought stress treatment was carried out by maintaining the soil water content (KAT) and carried out at 1 BST for 1 month. At the beginning of the study, all treatments were conditioned in 100% KAT (field capacity) and then weighed to determine the wet weight of polybag soil (BBP). Then the soil in the polybag is allowed to dry until the KAT is suitable for treatment. The field capacity treatment was maintained at 100% moisture content and 40% for the drought stressed treatment. To maintain KAT according to treatment, each polybag needs to be added with water. The amount of water that must be added to increase the KAT by 1%, then a soil sample is taken when the KAT is 100% and then weighed (BAC). The soil is oven-baked to obtain its dry weight (BKC) [7].

The amount of water contained in the soil sample (JAC) is JAC = BAC – BKC ………………… ml

The amount of water contained in each polybag (JAP) is $JAP = \frac{BBP}{BAC} \times JAC$…………………..…….. ml

The amount of water that must be added to increase KAT by 1% is $TA = \frac{JAP}{100} \times JAC$……………..… ml

2.2.5 Maintenance

Maintenance activities are controlling plant-disturbing organisms, fertilization. Weed control is carried out both weeding in and weeding out manually, while pest and disease control is carried out according to the economic threshold. Fertilization was carried out 2 times, when the plants were 3-4 weeks old using NPK 25 g and 12.5 g ZA/polybag and the second time at 3 BST with a dose of 25 g ZA/polybag [10].

2.2.6 Data Analysis

Observational data were analyzed using Analysis of Variance at 5% level and if there was a significant effect, then further tested with Duncan's Multiples Range Test at 5% level.

III. RESULTS AND DISCUSSION

3.1 Plant Height

Plant height is an indicator of growth that can be seen from the increase in plant size as a result of assimilation. Plants will respond through the expression of plant height when under stress condition. Plant growth is characterized by an increase in the size, shape, number and volume of plants.

TABLE 1
THE EFFECT OF DROUGHT STRESS ON THE HEIGHT OF FIVE SUGARCANE CLONES IN PEAT MEDIA

Clones	Plant Height (cm)		
	Field Capacity	Drought	Average
NX01	165.56	123.39	144.47 ab
BM1612	150.73	115.53	133.13 bc
PS881	175.86	129.86	152.86 a
BM1677	167.47	109.61	138.54 b
Local	139.77	105.39	122.58 c
Average	159.88 a	116.76 b	

Note: Numbers followed by different letters in the same column show significant differences according to the Duncan Multiple Range Test at 5% level.

Plant height was not affected by the combination of media water availability and five sugarcane clones. The availability of media water and five sugarcane clones significantly affected plant height although there was no interaction between the two (Table 1). Drought stress caused a significant decrease in the average plant height of 43.12 cm and clone PS881 was the clone that had the highest plant height of 152.86 cm compared to other clones under field capacity conditions and drought stress, followed by clone NX01 with plant height of 144.47 cm (Figure 1). This means that PS881 clones with genetic characteristics of early maturity can adapt to drought stress conditions. One of the responses of plants to stress is to accelerate their maturity with the aim of minimizing the impact caused by stress [11]. In addition, genetics is an innate trait that affects plant growth. Sugarcane growth is determined or is the result of the interaction between genetics and the environment, including drought stress. The genetic properties of different sugarcane clones have a significant effect on the total fresh weight of the plant, this condition is due to differences in responses to the environment [12]. The Indonesian Sugar Development Research Center has developed a PS881 clone with the characteristics of the clone being able to grow well on light to heavy soils. PS881 clone with early ripening characteristics is a clone that is recommended to be planted on land with a heavy textured land typology [13]. According to [14] drought stress reduced the plant height of barito tabby plants by 10.30%.

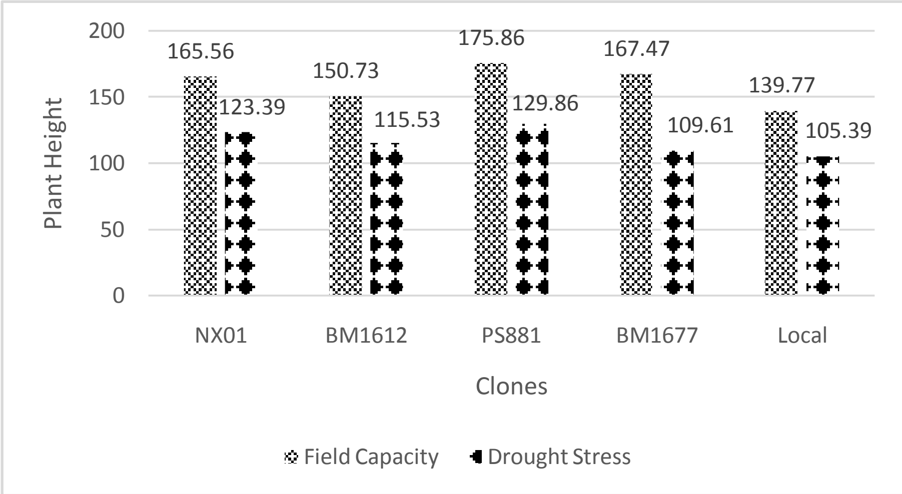

FIGURE 1: Effect of Drought Stress on Plant Height of Five Sugarcane Clones on Peat Media

3.2 Stem Diameter

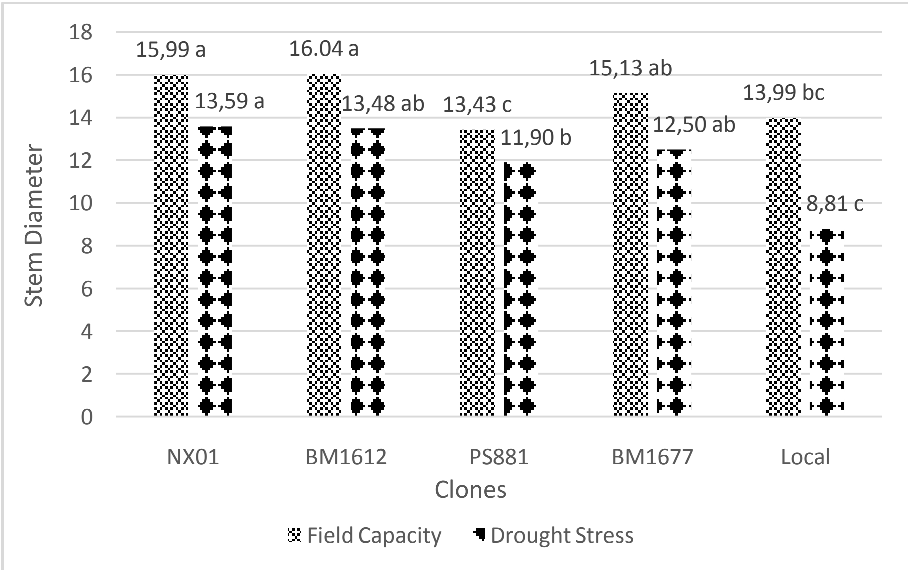

FIGURE 2: Effect of Drought Stress on Stem Diameter of Five Sugarcane Clones in Peat Media

The combination of water availability of planting media and five sugarcane clones affected the stem diameter of sugarcane (Figure 2). Drought stress caused the average stem diameter of five sugarcane clones to decrease. Drought stress caused the average stem diameter of five sugarcane clones to decrease. These results are in line with research conducted by [15] that drought stress resulted in a significant reduction in the size of sugarcane stems by 1.75 mm because cell division and elongation were disrupted. Under conditions of field capacity (100%) water availability, clone BM1612 had the largest stem diameter and was not significantly different from clones NX01, BM1677 as well as under drought stress conditions (40%). However, during drought stress conditions, clone PS881 was the clone that decreased its stem diameter by at least 1.53 cm compared to the other clones. This condition is a form of response to drought stress. This means that PS881 clone can adapt to drought stress conditions in peat media. Drought stress hinders the flow of water from the xylem to the meristematic tissue, resulting in inhibition of mitosis and cell enlargement. The main constituent of plant tissue, especially meristematic tissue, is water, which plays a role in activating physiological processes either directly or indirectly by maintaining cell turgidity. [5] that clone PS881 showed significantly better stem diameter, stem height, stem weight and number of internodes on dry land on ultisol soils.

3.3 Number of Leaves

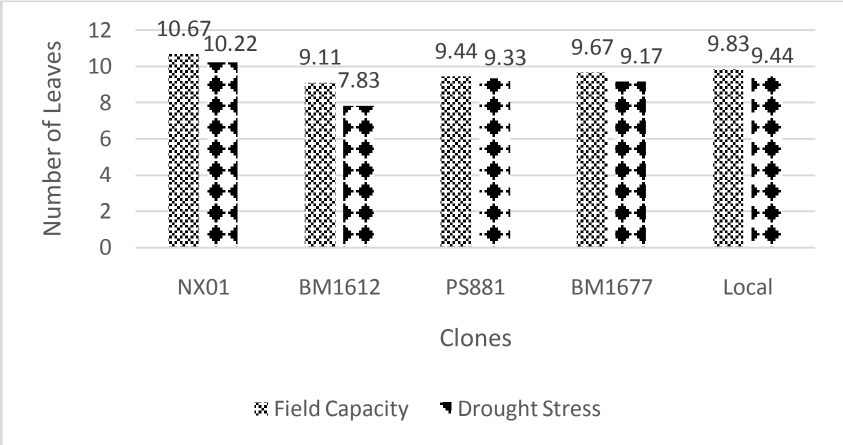

FIGURE 3: The Effect of Drought Stress on the Number of Leaves of Five Sugarcane Clones in Peat Media

Figure 3 shows the results of observing the number of leaves of 5 sugarcane clones in field capacity and dry media water availability. These results showed that the number of sugarcane leaves is not affected by the availability of media water, clones or a combination of both. Based on direct observation on the availability of water in field capacity media, clone NX01 had the highest number of leaves, namely 10.45 and clone BM1612 had the least number of leaves, namely 8.47. Drought stress conditions resulted in a decrease in the average number of leaves in several sugarcane clones. PS881 clones tended to have the least number of leaves decreased compared to other clones under field capacity and dry conditions (40%), followed by local clones and BM1612 clones decreased leaf numbers the most by 1.28. This means that the PS881 clone has the highest resistance to drought stress on peat media compared to the other four sugarcane clones tested. The PS881 clone was able to maintain the growth of the number of leaves under conditions of field capacity water availability in the media (100%) and dry stress conditions of 40%. This indicated that the sugarcane clone PS881 was able to maintain turgor pressure at 40% drought stress. Turgor pressure in plants affects plant cell propagation, leaf and flower development and movement in other plant parts. Turgor pressure can be influenced by the availability of water in the media, as a consequence of drought stress plants will tend to maintain turgor pressure [16].

3.4 Number of Tillers

The combination of media water availability and sugarcane clones had no effect on the number of tillers. The results of direct field observations showed that under field capacity conditions of water availability, clone BM1677 was the clone that had the highest number of tillers, namely 4 tillers and clone NX01 was the clone which had the least average number of tillers, namely 1.67. However, in drought stress conditions, clone NX01 increased the average number of tillers by one tiller, followed by local clones, while other clones, namely BM1612, PS881 and BM1677 under drought stress conditions, decreased the number of tillers by an average of 0.65 (Figure 4). As long as sugarcane plants are in conditions of limited water supply or drought stress, cell development will be hampered so that tiller growth will also decrease [16] [17] [18].

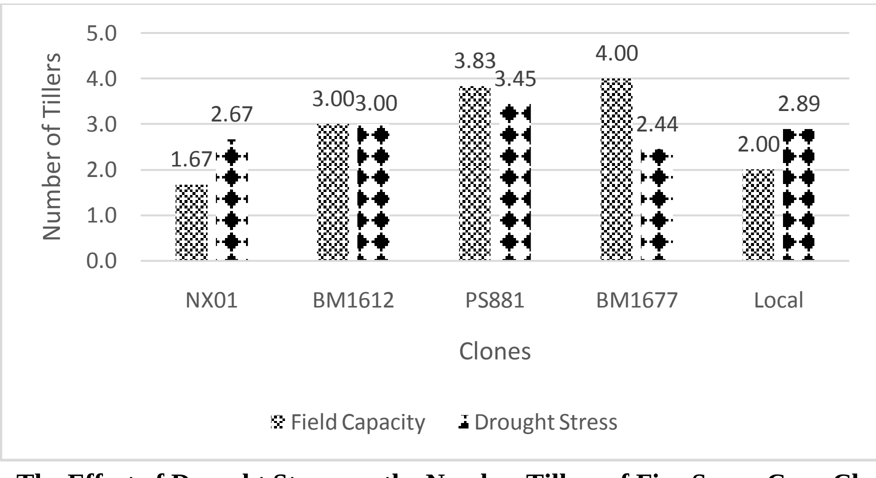

FIGURE 4: The Effect of Drought Stress on the Number Tillers of Five Sugar Cane Clones in Peat

IV. CONCLUSION

The availability of media water and sugarcane clones affected the height of sugarcane plants at initial growth, but did not affect the number of leaves and number of tillers. The diameter of the stems of sugarcane in early growth was influenced by the combination of the availability of media water and five sugarcane clones. PS881 is a clone that can adapt to drought stress conditions (40%) in peat media based on growth indicators of plant height, stem diameter and number of leaves.

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