INORGANIC FORMULATION FOR PESTICIDAL CONTROL AND ITS EFFICIANCY ON MAIZE YIELD

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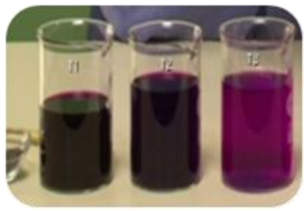
ABSTRACT

Pesticides are compounds with strong insecticidal properties that are used to manage undesired plants, animals, and microbes. In the current era, increase in world's population effect the essential human needs like food, healthcare, and many more others. The main objective of this research was to formulate inorganic pesticide spray and its efficiency in maize crop. For this purpose total eight spraying sessions were applied on Faisalabad's maize crop. Physiochemical analysis of Faisalabad soil were assessed before and after the use of formulated and standard insecticide spray. The following pests were selected for the experiment: *Zyginia sp.* (maize jassid), *Athenigona sp.* (shot fly), *Chilo partellus* (stem borer), and *Rhopalosipuon onqids* (maize aphid). Three maize crop plots were chosen as the control, treated, and standard. The following inorganic chemicals were used for the formulation of pesticide spray: boric acid, potash alum, sodium bicarbonate, and copper sulphate. The findings of the physiochemical investigation demonstrated that the prepared spray had no adverse influence on the physiochemical parameters of Faisalabad soil prior to and after application. The pesticidal potential study revealed that inorganic pesticidal spray has a considerable effect on insect infestation management compared to the control and standard.

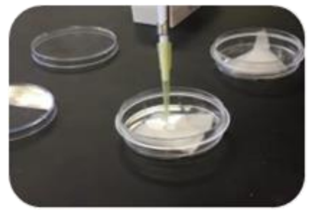
Keywords: inorganic pesticide formulation, maize crop, soil's physicochemical analysis, food

Graphical Abstract

Soil samples



Inorganic pesticidal formulations



Setup of bioassay for contact toxicity of pest

Experimental area (Zea maize crop)

1. INTRODUCTION

Insecticides are chemicals or group of substances that regulate, prevent, destroy and diminish the population of pests (Laohaudomchok et al., 2020). Despite this, insecticides are the most effective way to keep these pests at bay and maintain maize production. There are several biotic and abiotic variables that contribute to the yearly decline in maize production (Bueno & Ghoshl, 2022). These involve pests, which significantly contribute to the inadequate production of maize (Sharma et al., 2019). The corn root borer (*Chilo partellus*) is a destructive insect pest in Pakistan (Fikadu, 2020). The second most damaging pest to maize is the maize aphid. Crops become yellow-brown and wilt as a result of aphids, which proliferate on plant sap and are frequently observed in high populations (Radwan & Gad, 2023). The shoot fly (*Atherigona naqvii*), one of the most harmful insects to spring corn, can lower outputs up to sixty percent (Lara-Esqueda et al., 2021). It causes significant losses when the crop is still in the seedling stage (Virla et al., 2021). The prior research found that transitional and subsistence farmers in low-income nations frequently use formulated pesticides. Their usage is frequently motivated by the expensive or scarce nature of commercial insecticides (Rahman, 2020). Agricultural extension agencies and other development organizations frequently advise using formulated pesticides (Almeida,Lemmens, De Meester, & Brans, 2021). Contrarily, traditional insecticides are dangerous and costly (Jabbarzadeh, 2022). Copper was classified as an insecticide by the US Environmental Protection Agency in 2008, and copper-based products are routinely employed in a range of agricultural contexts. Despite being typically secure to handle, copper is used yearly in the billions of carats, mostly for agricultural protection (Almeida,Lemmens, De Meester, & Brans, 2021). Even before synthetic carbon-based pesticides were created, boric acid (BH_3O_3) was successfully used as a pesticide to control insects in urban, medical, and agricultural contexts (Pscheidt & Ocamb, 2022). For the management of infestations of insects in households and fields, regulars and professionals who execute pest control have easy access to the treatments of boric acid, which comes in the form of unit's aerosols, powder inducements, bonds, liniments, or solutions (Sierras, Wada-Katsumata, & Schal, 2018). possessing a chemical formula for potash alum Sustainable pesticide $KAl\ (SO_4)_2.12H_2O$ leaves the environment clean and nature's resources are used to the best extent possible (Olufelo, 2022). Many investigations have demonstrated that different disinfectants can reduce the bioload on green vegetables that are fit for ingestion. Numerous studies have employed the combination as a preventive against a variety of illnesses (Bueno & Ghoshl, 2022). Utilizing the impregnated filter paper method as the major bioassays to choose modern pesticide and their most effective concentrations that influence the pest in addition to evaluate pest resistance (Tudi et al., 2021). In this study, we target to do soil physicochemical analysis after and before the pesticides (formulated and customary market spray) application, formulation of pesticide using inorganic reagents, and its insecticidal potential was dignified in *Zea mays* (maize) plots in the season of autumn 2022.

2. MATERIAL AND METHOD

2.1 Soil physicochemical analysis (part: 1)

To conduct a physiochemical analysis of soil and evaluate its suitability for pesticide use, soil samples were gathered from Gojra city in the Toba Tek Singh district. A total of nine dry soil samples were collected at three different depths (0-10 cm, 10-20 cm, and 20-30 cm) from each of the treated, standard, and control plots, both before planting and after harvest. The physicochemical properties of the soil that were analyzed included bulk density, porosity, soil texture, soil saturation, hydraulic conductivity, organic carbon content, pH level, and electrical conductivity (Ogura et al., 2021).

2.1.1 Soil's Bulk density

The soil's bulk density was observed using the core methodology, which Tudi (2021) describes. Undisturbed soil cores were collected from three different depths (0-10 cm, 10-20 cm, and 20-30 cm) and placed into a single cylinder made of edge-honed galvanized iron, which had an inner diameter of 7.2 cm and a height of 6.2 cm. This was achieved using a small hammer and a piece of wood to ensure minimal soil disturbance. To maintain the soil's moisture level at approximately 10% to 12%, the sampling process was conducted. Afterwards, the dry soil cores were weighed, and their mass was recorded. Subsequently, these samples were carefully stored and dried for 24 hours at a temperature of 10°C. The ratio of dry weight to interior volume of the soil core was expressed as bulk density and measured in units of Mega grams per cubic meter (Mg m-3)(Tudi et al., 2021).

2.1.2 Soil porosity

The porosity of soils refers to the number or percentage of pores present in a given amount of soil (Damalas, 2021). Applying the core technique, the porosity percent at three distinct depths (0–10 cm, 10–20 cm, and 20–30 cm) was determined (Arispe-Vázquez et al., 2021).

2.1.3 Soil texture

Soil texture was dignified through hydrometer technique charted by Bouyoucos (1962), percentage of the sand, sludge, or mud was noted through hydrometer whereas, sodium hexametaphosphate assisted as a scattering agent.

2.1.4 Soil's hydraulic conductivity

Soil's hydraulic conductivity was determined using the technique of ring infiltrometer (Ashesh, Singh, Devi, & Yadav,2022). It is a 5-centimeter-tall, thin-walled cylinder with an open end. Water enters through the rings using a falling mechanism. After that, pore area was calculated to illustrate geographical variability (Allerton, Todd, Jacobs, & Prober, 2020).

2.1.5 Soil's organic carbon

It was measured by means of oxidation technique (wet) at three pits (0-10 cm, 10-20 cm and 20-30 cm) (Alam et al., 2019).

2.1.6 Soil pH analysis

The soil pH was determined via glass and reference electrode with nine samples at the depths (0-10 cm, 10-20 cm and 20-30 cm) through digital pH meter (Arispe-Vázquez et al., 2021).

2.1.7 Electrical conductivity of soil

A digital Jenway electrical conductivity meter was used to determine electrical conductivity at three different soil levels subsequently the probe has been adjusted with 0.01 solution of N KCl (Uhl & Brühl 2019).

2.2 Formulation of pesticide spray

Formulation of 3 distinct amounts of inorganic reagents (F1, F2 and F3) of selected chemicals were prepared. F1 consisting of Copper sulfate with the concentration 35 mM, potash alum 10 mM, boric acid 100 mM, sodium bicarbonate 75 mM and potassium permanganate 15 mM. F2 consisting of Copper sulfate 40 mM, potash alum 15 mM, boric acid 105 mM, sodium bicarbonate 80 mM and potassium permanganate 20 mM. F3 consisting of Copper sulfate 45 mM, potash alum 20mM, boric acid 115 mM, sodium bicarbonate 85 mM and potassium permanganate 25 mM. Then, 4 liter of distilled water was added and agitated well on 250 rpm at the room temperature. After thirty hours, solution blends were complete to be sprayed on maize plots.

2.3 Bioassay for contact toxicity of pest

The dipping impregnated filter paper method was applied in the bioassay to determine contact toxicity of the insecticides (Mian et al., 2022) on four mature pests: Chilo partellus, shoot fly, maize jassid, and maize aphid, which was approved by the Zoology department at Riphah international university FSD. At same time, after the 1, 3, 5, and 7 days, mortality for all pest was documented in the excel sheet.

2.4 Experimental design and land preparation (part: 2)

Experiments were done on farmer fields of Faisalabad, Punjab. The pioneer variety of maize was sown in autumn season 2022 in three selected plots treated, standard and control where the area per plot kept 30 m^2 with the 75 cm row distance and 20cm plant distance from each other.

2.5 Treatments (part: 3)

The control plots were left exposed to insect invasion, whereas infestations in treated and standard plots were maintained by applying a formulated and standard pesticide (SEGA pest clear) to suppress the pest. During the 10-day span, seven spraying operations were carried out. While standard plots were treated with normal market spray, treatment plots received the utmost effective formulated mixture (F2), which stood assessed using bioassay approach. Both plots stood observed every ten days starting after twenty days of propagation. The variations in climate, including fluctuations in temperature, humidity, as well as rainfall, were also measured using the portable weather meter. The department of Zoology at Riphah International University FSD confirmed that the four pest chilo partellus, shoot fly, maize jassid, and maize aphid were present throughout the crop across the experiment.

2.6 Statistical analysis

The statistical analysis of this study were conducted using SPSS (Abubakar et al., 2020).

3. Results

3.1 Soil's physicochemical analysis

3.1.1 Soil's bulk density

Future agricultural productivity also soil productivity are significantly influenced by soil bulk density. Bulk density mimics how the soil functions in terms of providing structural support, moving water and nutrients, supporting microbial life, and aerating the soil. Bulk density is affected by the kind of soil present since high porosity clays have more pores than coarse grained sands, which have fewer holes (Tudi et al., 2021). Table 1.1 displays the statistical significance of the bulk density of treated plots that were sprayed with pesticides prior to planting and after harvest. Data analysis reveals that soil bulk density was reduced at deep. The lowest recorded soil's bulk density stayed 1.43±1.21 g/cm^{-3} at the pits of 0-10 cm and 1.60±1.52 g/cm^{-3} at the 20-30 cm depth after the application. Moreover, the soil bulk density after the application was somewhat higher than before application. However, standard plot was sprayed by the customary insecticide (SEGA pest) significantly rise in bulk density was recorded as revealed in table 1.1. The soil bulk density of standard plot after the application or at the time of harvest was significantly higher. As shown in table 1.1, the highest recorded soil's bulk density stood 1.74±1.70 g/cm^{-3} at 20-30 cm inwards after the application although, the lowest recorded soil bulk density was 1.44±1.37 (g/cm^{-3}) at 0-10 cm depth before application.

3.1.2 Soil porosity

Soil porosity is the pore spaces in the soil among mineral particles (W. Ali et al., 2018). The soil porosity of the treated plot is shown in Table 1.1 before application and after the harvest using nine soil samples taken at three different depths.. The lowermost recorded soil porosity was 0.38±0.30 m^3 m^{-3} at 10-20 cm depth before application however the maximum recorded soil porosity was 0.46±0.39 m^3 m^{-3} at 0-10 cm depth after the application. The results indicate that the standard plot exhibited a high level of porosity, as presented in Table 1.1, whereas the treated plot displayed a lower porosity level. Furthermore, the data demonstrates a decrease in porosity as soil depth increases.

Table 1.1: *Soil's bulk density before planting and after harvest*

Physiochemical Properties	Depth cm	treated plot		standard plot	
		before planting	after harvest	before planting	after harvest
Soi'sl Bulk Density (g/cm^{-3})	0-10	1.43±1.21	1.49±1.27	1.44±1.37	1.58±1.49
	10-20	1.45±1.32	1.52±1.43	1.50±1.42	1.67±1.61
	20-30	1.48±1.35	1.60±1.52	1.56±1.55	1.74±1.70
Soil porosity (m^3 m^{-3})	0-10	0.43±0.21	0.46±0.39	0.46±0.40	0.53±0.51
	10-20	0.38±0.30	0.40±0.37	0.44±0.41	0.50±0.48
	20-30	0.38±0.37	0.41±0.40	0.44±0.41	0.51±0.45

Soil Saturated hydraulic conductivity (cm s^{-1})	0-10	3.72±3.61	3.46±3.21	3.76 ± 0.09	2.86 ±2.71
	10-20	4.18±4.02	3.90±3.65	3.99 ± 3.76	2.98±2.91
	20-30	4.24±3.97	3.91±3.07	3.98±3.67	3.81±3.63
Soil pH	0-10	6.3±5.9	6.6±6.4	7.6±7.3	7.9±7.5
	10-20	6.8±5.23	7.1±6.8	7.8±7.4	8.0±7.8
	20-30	7.5±7.4	7.8±7.5	8.6±8.1	8.8±8.6
Electrical conductivity (dS m^{-1})	0-10	1.61±1.52	1.52±1.50	1.62±0.97	1.57±1.43
	10-20	1.61±1.56	1.49±1.41	1.63±0.85	1.58±1.42
	20-30	1.50±1.43	1.42±1.32	1.49±1.23	1.44±1.40
Soil's organic carbon (g kg^{-1})	0-10	10.58±10.24	10.15±9.78	9.45±9.43	9.05±8.91
	10-20	9.82±8.34	8.84±8.51	8.80±8.65	7.7±7.4
	20-30	9.06±8.91	7.14±7.06	7.84±7.45	6.67±5.91
Soil texture	20	Treated plot (before and after)	Standard plot (before and after)	Control plot (before and after)	
		Sandy clay loam	Sandy clay loam	Sandy clay loam	

3.1.3 Soil saturated hydraulic conductivity

Hydraulic conductivity of saturated soil controls soil hydrological activity, depends on infiltration, soil moisture, runoff, soil erosion, and ground water dynamics (W. Ali et al., 2018). Results reveled the considerable properties of insecticide on the plots, soil's hydraulic conductivity was somewhat decline after the use of insecticide as displayed in table 1.1. The lowest recorded soil saturated hydraulic conductivity was 3.46±3.21 cm s^{-1} after the application at 0-10 cm depth however highest recorded soil's saturated hydraulic conductivity was 4.24±3.97 cm s^{-1} before the application.

Table 1.1 reveled the consequences of soil's hydraulic conductivity of the standard plot, as the results illustrates the hydraulic conductivity of soil considerably decreases after the use of standard market insecticide spray. The lowest recorded saturated hydraulic conductivityof soil was 2.86±2.71 cm s^{-1} after the harvest and highest recorded was 3.99±3.76 cm s^{-1} at the depth of 10-20 cm.

3.1.4 Soil pH

The accessibility of the nutrients in soil is determined by soil pH. (Tudi et al., 2021). According to the literature, maize cannot grow on soil with a pH below 5.5 (Mian et al., 2022). Table 1.1 depicts how formulated pesticides affect soil conditions as pH levels gradually increase towards the basic range following spray application. The pH levels that were greatest and lowest were 8.1 during harvest and 6.2 prior to planting, respectively.

Table 1.1, on the other hand, displays the outcomes of control control plot following the application of a common pesticide from the market, which likewise raises the pH level of the soil. After harvest, the pH level reached a maximum of 8.8 and a minimum of 7.6 respectively.

3.1.5 Soil electrical conductivity

Electrical conductivity of soil (EC) is the term used to describe the level of salinity in soil. It provides an accurate assessment of soil structure, water availability, and nutrient availability and loss (Tudi et al., 2021). Table 1.1 illustrate the consequences of soil's electrical conductivity of the treated plot, in which it was decline after the application. The lowest observed soil electrical conductivity was 1.42±1.32 dS m^{-1} at 20-30 cm depth and highest recorded was 1.61±1.56 dS m^{-1} at 10-20 cm depth. The table 1.1 revealed the results of standard plot, with the increase in depth, the soil electrical conductivity was decreases. Also the soil's electrical conductivity of standard plot stood slightly greater than the treated plot.

3.1.6 Soil organic carbon

The magnitude and quality of organic substance in soil are important components in influencing soil fertility. The amount of soil organic matter is affected by a variety of elements, such as soil's climatic conditions, soil's management practices, cultivated crops, fertilization, agro procedural issues, etc. (Tudi et al., 2021).Table 1.1 illustrate the consequences of soil's organic carbon of treated plot as the lowest observed soil organic carbon was 7.14±7.06 g kg^{-1} at 20-30 cm depth however highest recorded was 10.58±10.24 g kg^{-1} before application at the depth of 0-10 cm and table 1.1 also shows the result of standard plot which revealed that with the rise in soil depth rise in organic carbon was observed in treated plot as compared to the standard plot.

3.1.7 Soil texture

The inspection of the mixture of sand, silt, and mud in the ground is called texture (Gowri & Thangaraj, 2020). Sand and mud are produced from the breakdown of rocks, while clay is created when specific minerals combine again (Tudi et al., 2021). Table 1.1 displays the results of soil texture for the selected plots, including the treated, standard, and control plots, at a depth of 20 cm. The soil texture was determined using the hydrometer method, and it was identified as "sandy clay loam" both before planting and after harvest.

3.2 Bioassay for the contact toxicity of pest

The bioassay's consequences of formulated reagent (F1) revealed that the mortality rate at day 1 was 0.00 ± 0.00 % with concentration 0.00 % and as the concentration of F1 reagent increase the mortality rate increases as the day's increases from 1 till 7. The lowest mortality rate was 0.21±0.08% with the applied concentration of 0.031% at day 1 whereas, the highest mortality rate was 9.00±8.81% with the applied concentration of 0.500% at day 5 and 7. So, the 0.500% concentration of F1 reagent was showed significant pesticidal potential as compared to the other concentrations of F1 reagent as shown in table 1.2.

Table 1.2: *Bioassay results of formulated reagents (F1, F2 and F3)*

Concentration%		Mortality %		
		Reagent F1	Reagent F2	Reagent F3
0.000	Day1	0.00±0.00	0.00±0.00	0.00±0.00
0.031		0.21±0.08	0.25±0.01	0.14±0.09
0.062		0.64±0.76	0.75±0.24	1.08±0.28
0.125		1.42±0.06	1.50±0.26	1.45±1.30
0.250		4.57±3.91	5.37±5.26	4.25±3.98
0.500		6.08±5.97	7.00±6.25	6.01±5.26
0.000	Day 3	0.00±0.00	0.00±0.00	0.00±0.00
0.031		0.67±0.61	1.00±0.16	0.91±0.65
0.062		1.15±1.21	1.88±1.58	1.71±1.54
0.125		3.00±2.45	3.13±2.97	2.04±1.97
0.250		5.25±4.91	7.00±6.91	6.93±6.71
0.500		7.33±7.32	8.37±7.01	7.78±7.31
0.000	Day 5	0.00±0.00	0.00±0.00	0.00±0.00
0.031		2.09±1.87	2.63±2.29	1.97±0.73
0.062		1.59±1.12	2.88±2.71	2.63±2.14
0.125		4.15±3.76	4.63±3.71	3.91±3.79
0.250		6.57±6.56	8.50±8.10	6.54±6.38
0.500		8.78±8.63	10.00±9.23	9.34±9.21
0.000	Day 7	0.00±0.00	0.00±0.00	0.00±0.00
0.031		5.76±5.45	6.00±5.58	5.00±4.84
0.062		6.44±6.24	7.40±7.61	6.61±6.21
0.125		7.74±7.61	8.50±8.43	7.98±7.38
0.250		8.80±8.42	9.88±9.58	9.97±9.86
0.500		9.00±8.81	10.00±9.87	9.98±9.71

The bioassay results of formulated reagent (F2) revealed that the mortality rate at day 1 was 0.00 ± 0.00 % with concentration 0.00 % and as the concentration of F2 reagent increase the mortality rate increases as the day's increases from 1 till 7. The lowest mortality rate was 0.25±0.019% with the applied concentration of 0.031% at day 1 whereas, the highest mortality rate was 10.00±9.87% with the applied concentration of 0.500% at day 5 and 7. So, the 0.500% concentration of F2 reagent was showed significant pesticidal potential as compared to the other concentrations of F2 reagent. The bioassay results of formulated reagent (F3) revealed that the mortality rate at day 1 was 0.00 ± 0.00 % with concentration 0.00% and as the concentration of F3 reagent increase the mortality rate increases as the day's increases from 1 till 7. The lowest mortality rate was 0.14±0.09% with the applied concentration of 0.031% at day 1 whereas, the highest mortality rate was 9.98±9.71% with the applied concentration of 0.500% at day 7. So, the 0.500% concentration of F3 reagent was showed significant pesticidal potential as compared to the other concentrations of F2 reagent. . The F2 reagent, however, was shown to be the most efficient of the three reagents (F1, F2, and F3), and the adult pest death rate rose as the pesticide concentration increased.

3.3 Field experiments

On July 5, 2022, hybrid maize seeds (SOHNI DHARTI 626) were planted during the fall season. The experiment involved three types of plots: treated, standard, and control, each with three replications (n=3). Each plot had an area of 30 square meters. The treated plots were subjected to F2 spray, a formulated pesticide reagent, while the standard plots were sprayed with the market-standard pesticide (SEGA pest clear). The control plots were left untreated and exposed to potential pest infestations. During the course of the experiment, the maize crop faced attacks from various pests, including maize stem-borers, maize aphids, shoot flies, and maize jassids. To manage these pests and control maize diseases, eight spraying sessions were conducted. A CO2 pressurized sprayer tank equipped with a flat-fan nozzle was used for spraying. The spray volume applied per plot was 110 liters, with a pressure of 300 KPa. The spraying was performed at a constant working speed of 3 kilometers per hour.

3.4 Maize stem-borer

During the study, in the control plot, maize stem borers were observed to become destructive approximately two weeks after planting, starting after July 20. As indicated in Table 1.3, the level of destruction began in the last week of July, with the following percentages recorded: 2.66% ± 2.13% in the treated plot, 11% in the standard plot, and 27.34% ± 26.10% in the control plot.

Table 1.3: *Plants infested (percentage) by maize pests in treated, standard and control plot*

Plots	Concentration	Maize pest	Infested plants %
Treated	5L/plot	Maize stem-borer	2.66±2.13
		Maize aphid	1.63±0.97
		Maize shoot fly	0.68±0.41
		Maize jassid	2.47±2.36
Standard	5L/plot	Maize stem-borer	11±10.45
		Maize aphid	12.95±12.62
		Maize shoot fly	7.81±7.62
		Maize jassid	15.41±14.91
Control		Maize stem-borer	27.34±26.10
		Maize aphid	28.75±28.15
		Maize shoot fly	18.13±18.09
		Maize jassid	27.35±27.10

3.5 Maize aphid

According to the table1.3, aphid invasion arose in the last week of August with the 1.63±0.97% in treated, 12.9±12.62% in the standard and 28.7±28.15% in the control plot.

3.6 Shootfly

The infestation of shoot flies began around mid-July, and by the first week of August, it had reached its peak level of infestation, as indicated in Table 1.5. During the experiment, the following damage percentages were observed: 0.68% ± 0.41% in the treated plot, 7.81% ± 7.62% in the standard plot, and 18.13% ± 18.09% in the control plot caused by shoot flies.

3.7 Maize jassid

The invasion of maize jassids began when the crop reached a height of one foot and persisted until crop maturity. This invasion initiated in the middle of August and extended until the middle of September. According to Table 1.3, the levels of infestation were as follows: 2.47% in the treated plot, 15.41% in the standard plot, and 27.35% in the control plot.

3.8 Comparison of treated, standard and control plots

A statistical analysis of the data indicated a significant difference in grain yield between the treated and control plots. The results clearly demonstrate that the treated plot, which received the formulated pesticide spray, achieved a notably higher grain yield compared to both the standard and control plots. Specifically, the grain yield for the treated plot was 18.88 kg per plot. In contrast, the standard plot, which received the standard market spray, had a grain yield of 9.10 kg ± 8.21 kg per plot, and the control plot yielded only 2.39 kg ± 2.34 kg per plot. The treated plot exhibited the maximum grain yield, while the control plot had the lowest yield. In summary, these results, as depicted in Figure 1.1, underscore the superior effectiveness of the formulated pesticide spray in comparison to the standard market spray. Additionally, the formulated pesticide spray proved to be environmentally friendly, as it did not harm pollinating insects or birds and was easy to handle.

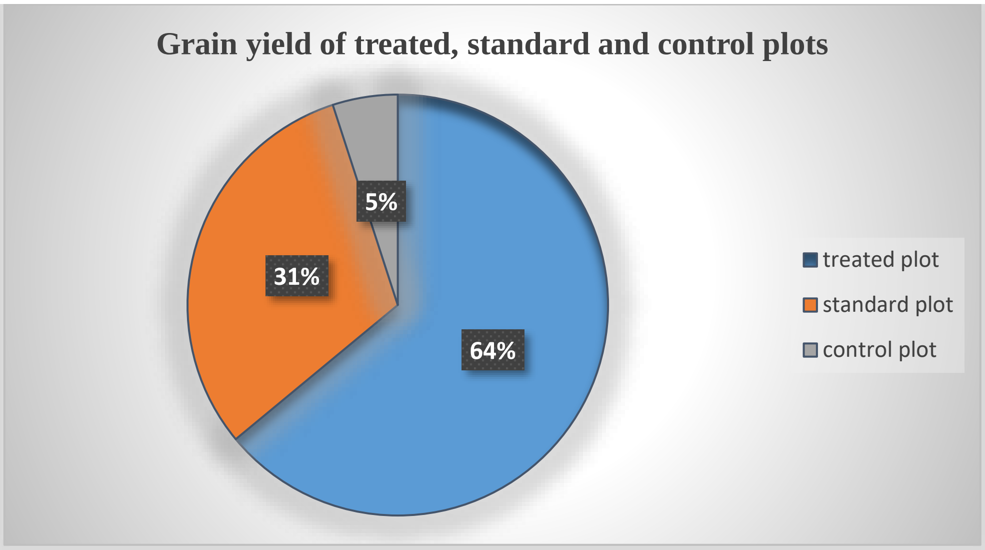


Figure 1.1: *Comparison between the yield % of treated, standard and control plots*

3.9 Discussion

Based on a previous study (Otim et al., 2022), low-income subsistence and transitional farmers commonly rely on formulated pesticides. They often turn to these pesticides due to the limited availability or high cost of commercial alternatives. Additionally, agricultural extension services and some development organizations recommend the use of formulated pesticides (Mian et al., 2022).

The treated plots were subjected to the application of a formulated insecticide, while the control plots received the conventional market spray (SEGA pest clear) simultaneously on the same dates. However, the results reveal a significant difference in the average grain yield between these two types of plots. The treated plots outperformed the control plots, demonstrating higher grain yields. It's worth noting that the conventional market pesticide spray covers a broader area compared to the customized pesticide spray. According to the statistical analysis, the grain yield for the treated plot was 14.79 kg per plot, while the conventional plot yielded only 6.34 kg per plot. Additionally, the pesticide spray formulation proved to be non-toxic and environmentally friendly, as it had no adverse effects on pollinating insects or birds and was easy to apply.

The formulated pesticide spray utilized in this study exhibited a high level of solubility, which increased its likelihood to migrate with water and through the soil. Moreover, it was non-volatile, meaning it didn't readily evaporate into the air. The persistent nature of the formulated pesticide spray allowed for long-term insect control without causing stress to the crops. In contrast, the standard pesticide spray was found to be toxic upon contact with human skin, potentially leading to rashes and, in severe cases, even fatal outcomes. Additionally, the volatile nature of the formulated insecticide used in this study made it environmentally friendly, safe, easy to handle, cost-effective, and more efficient when compared to the typical market spray (SEGA pest control). Formulated pesticides, while less persistent, can offer greater selectivity than synthetic market sprays. However, applicators often need to possess more knowledge about the target pest to successfully control it using formulated pesticides.

Conclusion

Our research formulate inorganic pesticidal sprays and evaluate pesticidal potential in maize crop significantly. Physiochemical analysis results revealed that pesticidal sprays have effect the physiochemical properties of soil. So the inorganic pesticide sprays can be used in crops to control pests growth as a result of which yield will be increased and meet the need of food need with increase in population in future.

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