

Possible Integrated Pest and Soil Nutrient Management Intervention for Commercial Tomato (*Lycopersicon esculentum*) Vegetable Production in Chitwan, Nepal

Bikram Nepali, Sabin Bhattarai* and Surendra BK

Agriculture and Forestry University, Bharatpur, Nepal

***Corresponding Author:** Sabin Bhattarai, Agriculture and Forestry University, Bharatpur, Nepal.

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Abstract

The project aims to minimize the level of chemical use of poisons (pesticides) that has been found harming the soil, water, plant and human as well. Farmers often doesn't know how to use the poisons (pesticides) correctly, which results in them being affected by the poisons. This causes over 400,000 people to die each year in the world. The particular focus will be on the use of bio-pesticides and other eco-friendly pest managing compounds. The project aims to provide effective knowledge of integrated pest and nutrient management to the farmers and help them to solve the problems related to health, production and soil fertility.

Keywords: Pesticides; Eco-Friendly; Integrated Pest Management; Nutrient

Introduction

Tomato (*Lycopersicon esculentum*) is most popular staple vegetable grown universally as protective food is being extensively grown as an annual plant. It ranks second next to potato in global Vegetable production of the world. It is the second most popular and important vegetable crop of Nepal, in terms of area and production. The national figures show that tomato was cultivated on a total 19,726 ha producing 2, 98,594 mt in 2012/13 and decreased to 17, 273 ha producing 2, 32,897 mt in 2013/14. Average productivity was reported to be 15.1 mt/ha in 2012/13 and reduced to 13.5 in 2013/14 which is quite low compared to other Asian countries. In Nepal 3,243,521 people was holdings vegetable. Total Vegetable consumption is 1,100,710 metric tons (39%) and total sale contributed 1,719,818 metric tons (61%) among total production 2,820,527 metric tons (CBS 2009/10). Vegetable production in the terai, Mid-hill and high hills were recorded as 55%, 40% and 5% respectively (CBS and MoAC 2009/10). In Central Region of Nepal, Vegetable were cultivated in 88,987 ha of land, with total production 1,191,119 mt and average yield of 13,385 kg/ha.

Tomato (*Lycopersicon esculentum*) is also most popular as poor man's Orange and one of the Rich source of minerals, vitamins and Organic acid. Tomatoes are consumed directly as raw vegetable in

sandwiches, salad, etc and several processed items like pasta, puree, syrup, juice, ketchup, jam, etc. are prepared in large scale. Tomato is a very good appetizer and its soup is said to be a good remedy for patients suffering from constipation. Besides of Tomato being tasty it contains ambient amount of Vitamin A and Vitamin C. Lycopene is very powerful antioxidant which help preventing form the development of many forms of Cancer. Currently the consumption rate is higher and demand of Tomato is increasing day by day in case of off-season in Nepal. So, often referred as a luxury Crop. Tomato is well easier to grow in more marginal condition and important diet of developing country like Nepal.

There are several factors that affect the productivity of Tomato; however, the fertilizer management is one of the most important factors that affect the growth and yield of Tomato. Effective supply of fertilizer through inorganic and organic sources may increase the production of tomato as well as improve the quality of food grains and soil environment. Crop responses to chemical fertilizer is quick and effective to yield but this retrain the soil nutrient, texture and soil biodiversity, which required thousands of year to recover due to excessive use of chemical fertilizer for long period of time. In Nepal people were commonly using weedicide that also affecting the soil fertility. Chemical pesticide is commonly practice culture for

pest management in Nepal. Overuse and misuse of pesticides have several acute and chronic adverse health consequences of Nepalese people (NHRC, 2014). Organophosphate insecticide is commonly used pesticide in Nepal which inhibits the neurotransmitter acetyl cholinesterase and affects the central and peripheral nervous system. Organophosphate and organochlorine affect the endocrine system which can lead to diabetes mellitus (NHRC, 2014). Along with this, we also aimed to find out the level of blood sugar among pesticide exposed vegetable farmers in Nepal. Vegetable farmers had considerable knowledge regarding health impacts of pesticide. However, they did not adopt the safety precaution resulting higher risk of exposure with pesticide intoxication (NHRC, 2014). This bitter aspect may be attributable partly by the unavailability of the improved nutrient and pest management of the Vegetable, meager availability of the essential inputs and partly due to the management practices of the vegetable. Mostly tomato is grown in the adequate moisture soil condition with high levels of monetary and non-monetary inputs. This statement shows that under good nutrient and pest management conditions yield potential of tomato could be increased [1-6].

Statement of Problem

The major crops grown by the farmers are rice, maize, wheat-like cereal crops and vegetables like tomato, cauliflower, cabbage etc but in a subsistence way due to the small amount or piece of land they own. The cause of the reduced yield from the crop grown is the pest, disease, birds, wild animals, rodents, nematodes and pathogens along with the weeds. Their infestation or attack has always been one of the most major issues while dealing with the crop cultivation. Every year there is the outburst of a new pest or some sort of disease which cause the significant amount of crop yield loss. Tomato being one of the major vegetable crops grown in Nepal has encountered many pest and diseases. Farmers have reported that several pests have attacked the plants viz. Stem borer, flies, nematodes, beetle and leaf minor. Along with the pest's problem farmers observed fertility problem in soil. These problems have direct concern with production and yield of tomato. Since most of the farmers are commercially involved in the production process, they are not willing to take risk and hence will increase the use of pesticides. This erroneous and inappropriate use of poison has obvious effect

on plant, human and destroys the natural predator of pests. In long run, use of such pesticides will cause the soil fertility problem i.e. by the deposition of chemicals/pesticides into the soil layers. According to the Nepal Health Research Council (NHRC), the trend of pesticide use is increasing in Nepal by about 10 - 20% per year. Studies have shown that more than 90% of the total pesticides are used in vegetable farming. A study showed that chemical pesticides are used by 25% of Terai households, 9% of mid Hill households and 7% of Mountain households. In certain mid hill pockets close to urban markets, the pesticide use is considerably higher. In Nepal, organochlorine was more popular in the past and organophosphate at present. Organophosphate inhibits the neurotransmitter acetyl cholinesterase and can affect the central and autonomic nervous system. Few leading symptoms related to the autonomic nervous system are abdominal cramps; nausea, diarrhea, salivation, miosis and symptoms related to the central nervous system are dizziness, tremor, anxiety, and confusion. Symptoms usually occur within hours of exposure and typically disappear within days or weeks as new cholinesterase is synthesized.

Rationale of the study

The improper use and handling of pesticides not only affect the biodiversity around the crops but also the health of plant and human. Over use of poison destroys the natural predator of pests and insects. IPM approach doesn't mean to avoid the use of chemicals completely but it refers safe use of it. IPM mostly focuses on working organically and sustainably. Under the present scenario, many studies have shown that farmers are misusing pesticides and are not properly following the procedure while mixing, spraying the pesticides in their farm (NHRC, 2014). First step to detect the impacts of pesticides on human health, measuring AChE (Acetyl Cholinesterase) levels in human blood serum has been done only in very few studies and these studies have only been confined to small areas or population. This study was carried out by the Nepal Health Research Council (NHRC) in the fiscal year 2070/71 in order to assess the impact of pesticide use on human health. This study aims to measure the health impact of the pesticides specifically by measuring the AChE level in the human blood samples (NHRC, 2014). Along with this, we also aimed to find out the level of blood sugar among pesticide exposed vegetable farmers in Nepal.

Review of Literature

A comprehensive review of literature becomes an essential aspect of any scientific investigation. Tomato is one of the most important vegetable crop of the globe and Pest and nutrient management is challenging that affects with tomato for various factors. Mainly literatures related to pest and nutrient management and its impact on the yield are studied under this section.

Consequences of IPM and Integrated Nutrient management on a vegetable crop, i.e. Tomato

Just like people are healthy with a nutritious and balanced diet, the soil is also healthy with plenty of organic matter, nutrients, micro-organisms, etc. It then supports healthy plants, which can resist disease. Unrotted compost can cause pests and diseases in the soil, so always use well-rotted compost. Water is essential for the soil and plants. Having the right amount of water at the right time helps plants to grow, stay healthy and resist pests and disease. Crops attract certain types of pest and disease. Always planting the same crops in the same place causes those pests to increase and damage the crops. This is why crop rotations are beneficial. For example, potatoes and their relatives - tomato, auberge, sweet pepper, etc. shouldn't be planted in sequence on the same piece of land for up to 2 years. The rotation helps to break the pest and disease cycle, so they will not harm the next crop. After crops that attract many diseases are harvested, such as potatoes and other vegetables, planting onions or garlic for a season helps to clean the soil of the many pests and diseases attracted by the previous crop.

Continuous monoculture planting of the same crop will always suffer more from pest attack. For example, if only cauliflower is planted, a fungus or insect which feeds on cauliflower can destroy the whole crop in a very short time, and is difficult to control. This why it's good to plant a variety of crops together, called mixed cropping. It's possible to plant many types of vegetable in the kitchen garden. For example, cauliflower, Swiss chard, radish, carrot, peas, broad bean, lettuce, turnip, coriander, fennel, dill, kohlrabi, spinach etc. can all be planted together. If anyone of these is attacked by a pest, there are all the others that will still give production. The chapter Mixed Vegetable Gardening gives detailed information on this technique.

Companion Plant: Plants give each other various types of support. For example, the scent of garlic helps repel many types of pest. Marigold gives a chemical from its roots which helps to repel soil nematodes which otherwise eat plant roots. The flowers of marigold

also give a strong smell which help to repel insect pests. Some insects recognize the smell of the plants they eat, so strong smelling repellent plants help to protect these vegetables. Legumes such as peas and beans help to provide extra nitrogen to other plants. Mixing these plants with grains, vegetables, fruits or any type of crop to help protect them is called companion planting. Marigold, mint, basil, lemon grass, wormwood, garlic, onion, coriander, fennel, dill, nasturtium, tansy, etc. are all companion plants and it is beneficial to mix them with and around other crops. Harmful insect pests will eat other plants as well as the crops farmers plant. So, if these are added to fences around the crops, or even mixed in with the plants, these will be attacked instead of the crops. This is called decoy planting. For example, an insect that attacks cotton plants also eats the castor oil plant. So, by planting castor around the cotton plants, the cotton can be saved. Like this, nettles will attract caterpillars, which prevent them eating vegetable crops.

Observation

The most important work in integrated pest management is observation. Which pests are harmful, to which crops, at what time? Where do they come from? How do they breed? What can be done to prevent them coming? By understanding these things, the life cycle of the pest can be understood and so can be interrupted to prevent the pest becoming a pest.

In this way pests can be prevented early on from being harmful to our crops.

Materials and Methodology

The commercial vegetable farm was conducted at farmer land of Bharatpure-15, Phulbari, Chitwan, Nepal. The vegetable farm was established during the winter season of 2018/19. Before the establishment of farm, our team member decided an individual farmer questionnaire survey, who are already contributing commercial vegetable farm in Chitwan district. In our survey most of the farmer are following chemical fertilizer and pesticide for soil nutrient management and pest control, while few of them practicing bio/organic pesticide and fertilizer yet for quality/fresh organic vegetable. They have not treated seed with any fungicide or bio-fertilizer before sowing yet. Mostly farmer are using chemical fertilizer: Nitrogen, Phosphorous and Potassium and Bio/organic fertilizer: Farmyard manure, Vermicomposting, Poultry manure, mustard cake, Green manure (*Sesbania rostrata*, young mustard), Neem cake, etc. along with solarization of field, water stagnation in field, intercropping practice, etc. for soil nutrient management, also farmer recommend us to prefer more organic farming practice. Commonly farmer are observing Helicoverpa, Tuta, Root knot, white fly, Damping off, Late blight, Leaf Curl, Nematodes, etc. fungal, bacterial and viral disease and pest in their field. Huge of farmer practicing organic pesticide for controlling those disease and pest like: Pheromone trap, sticky yellow trap, Neem liquid, Cow urine, etc. as primary treatment and chemical pesticide like: King star, king guard, Solman, King sticker, Admiure, Mashal, Cypermethin, chlorpyrifos, etc. as secondary treatment if critical condition occurs. Farmer are taking advice from pathologist and agriculturist after the disease and pathogenic symptoms are observed. According to survey, farmer is using pesticide unknowing without prevention.

Finally, After the focal group discussion of our team member we end to a conclusion with, Integrated soil and Pest management practice for sustainable commercial tomato vegetable farming practices were followed by using Plastic Mulching, drip irrigation, Soil inoculation of Bio-fertilizer and seed treatment with fungicide practices for Soil moisture, Nutrient, PH, quality and soil disease, whereas Black Light trap, Yellow sticky trap, Foliar spray of Trichoderma and pseudomonas bio-pesticide for fungal, viral and bacterial, plant to plant large space gapping, Pheromone trap, etc. for controlling pest.

Description of the field experiment

Location

An Individual farmer survey was conducted at Bharatpure-15, Phulbari, Chitwan, Nepal. It will be Operate during winter season

from January 2018 to February 2018. We selected the random commercial vegetable practicing farmer house for survey.

Tomato Farming was established at Bharatpure-15, Phulbari, Chitwan, Nepal, with an aim of 5 years plan. Farm area of 1 ha land is situated in Central terai of Nepal in Central development region. The region has sub-tropical humid climate and altitude of the site is 228 km above the mean sea level. It is located at 9 km west to Narayangadh, the inner terai of Chitwan valley. The farm site lies at 27040' North latitude and 84019' East longitude. The optimum of temperature is 21°C - 25°C.

Soil characters

Initial soil samples from the farm site from each corner were taken. Using Screw auger at depth of 0 - 15 cm depth soil samples were collected to record the initial physio- chemical properties of the farm sites. Composite samples were made and analyzed in the soil lab. The total nitrogen will be determined by Kjeldahl distillation unit method (Jackson, 1967), available phosphorous by Olsen's method (Olsen's., et al. 1954) and available potassium by flame photometer method. Organic matter was determined by Walky and Black method (1934) and pH by Beckman Glass Electrode pH meter (Wright,1939). The Ph of the farm field was 6-7. The soil nature varies from sandy loam to clayey loam.

Seed Variety, Seed Rate and spacing

For commercial farming we are using most popular variety in Nepal i.e. Srijana and Manisha with the rate of 200 - 300 gm seed respectively in each of one-hectare land. Each of both varieties were planting 75 * 60 cm of spacing.

Pruning and Training

The tomatoes which are under cultivation practices are of Indeterminate type. So, the Removal of Lower leaves and Axillary bud at the time of first Flowering promotes quality fruit size. Apart from the pruning in Indeterminate tomato, early and total yield are increased to a greater extend by training. The plants are trained with wires, strings/stakes and rope.

Economic Analysis

Cost of Cultivation

The cost of cultivation for each treatment will be calculated on the basis of local charges and prevailing market prices for different agri-inputs like labor, seed, fertilizer, machines and other necessary materials.

Gross return

Economic yield (grain) will be converted into gross return (Rs/ha) on the basis of local market prices of different commodities.

Net return

It will be calculated by deducting the cost of cultivation from the gross return.

Benefit: Cost Ratio

It will be calculated by using following formula
 B:C Ratio = Gross Return/Total cost of cultivation

Log Frame table

A log frame (also known as a Project Framework) is a tool for planning and managing development projects. It looks like a table (or framework) and aims to present information about the key components of a project in a clear, concise, logical and systematic way.

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumptions
Goal: To contribute to increase the productivity of Tomato in central terai of Nepal.	Increase in per capita availability of Vegetable Crop.	Reports of National Planning Commission and Agri-Business Promotion and statistics Division, GoN	Support from government and no natural calamities.
Purpose: To increase the productivity of Tomato based system by developing and disseminating the best Integrated Nutrient management practices.	By 2018, at least 15% of the Tomato grower will adopt best Integrated Soil and pest management practices	DOA report, MOAD report, NARC report, ABPSD, GoN	<ul style="list-style-type: none"> Dissemination and adoption process will be smoothly carried-out. No natural calamities occur
Outputs 1. Integrated soil and pest management practices under Commercial Tomato based system identified. 2. Effect of bio-fertilizers on yield of Tomato is identified. 3. Interaction of Organic and Inorganic sources of nutrient worked out. 4. Economics of Organic and Inorganic sources of nutrient use worked-out.	By 2018, best Integrated Soil and pest management practices identified and integration effect on yield and quality will be accurately quantified.	Result Seminar, Thesis Field visit report, Journal Articles	<ul style="list-style-type: none"> Weather and other conditions will remain normal. Timely availability of budget. Inputs are available on time
Activities: Field Survey, experiment and publication of the results.		Various Report	Cooperation from concerned institutions

Conclusion

- Using mulching technique, there is no problem of weeding, Soil become friable, Maintenance of Soil temperature, helps to kill soil nematode and bacteria, prevention of soil sprayed foliar disease to the tomato.
- Drip irrigation provide exact amount of water to plant and helpful to supply precisely quantitative amount of plant nutrient.
- Soil inoculation of Bio-fertilizer like: *Azotobacter*, *Pseudomonas* and *Azospirillum* provide symbiotic association rhizosphere relation lead to supply free atmospheric nitrogen, phosphorus and plant growth hormones.
- Black light trap, Yellow sticky trap and Pheromone trap help to trap the insect pest like: Moth, white fly, Aphids, etc.
- Using to *Trichoderma* help to reduce or prevent from infection of fungal disease to tomato plant.

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