DISSERTATION-I

SYNOPSIS

SUBMITTED BY

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(11719016)

In partial fulfillment for the award of the degree

of

Master of Science in Horticulture

(Vegetable Science)

Under the Guidance of

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Phagwara- 144411 Punjab, India

14th May, 2018

DECLARATION

I hereby declare that the synopsis entitled **"Effect of foliar application of different plant growth regulators on growth and yield of potato (*Solanum tuberosum* L.)"** is an authentic record of my work that will be carried out at Lovely Professional University as a requirement for the degree of **Master of Science** in discipline of **Horticulture (Vegetable Science)**, under the guidance of Dr. Monisha Rawat, Assistant Professor, Department of Horticulture, School of Agriculture and no part of this synopsis has been submitted for any other degree programme.

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CERTIFICATE

This is to certify that the synopsis entitled **"Effect of foliar application of different plant growth regulators on growth and yield of potato (*Solanum tuberosum* L.)"** is submitted in the partial fulfillment of the requirement for the degree of **Master of Science** in the discipline of **Horticulture (Vegetable Science)** is a research work that will be carried out by **Ankush Chaudhary (Registration No. 11719016)** under my supervision and that no part of this synopsis has been submitted for any other degree.

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INDEX

INTRODUCTION

Potato (*Solanum tuberosum* L.) belonging to the family solanaceae is a native of South America. It is the fourth most important food crop in the world after rice, wheat and maize and is the leading vegetable crop in the United States (**IPC, 2016**). More than a billion people worldwide eat potatoes and the total global crop production exceeds 300 million metric tons. Potatoes are grown in around 125 countries throughout the world, from China's Yunnan plateau and the subtropical lowlands of India to Java's equatorial highlands and the steppes of the Ukraine (**IPC, 2016**).

Potato contribute key nutrients to the diet including vitamin C, potassium, and dietary fibre (**Weaver and Marr, 2013**). In fact, it has a more favourable overall nutrient-to-price ratio than many other fruits and vegetables and is an affordable source of nutrition worldwide (**Rhem and Drewnowski, 2013**). However, the impact of potato consumption on human health remains somewhat controversial. Animal studies and limited human clinical trials indicate that potato and potato components may favourably impact cardio-metabolic health (**McGill *et al.*, 2013**).

Potato is agriculturally unique as it is vegetatively propagated, meaning that a new plant can be grown from whole potato or a piece of potato. The new plant can produce 5-20 new tubers, which will be genetically identical clones of the original plant. Potato plants also produce flowers and berries that contain 100-400 botanical seeds. These can be planted to produce new tubers, which will be genetically different from the original plant. There are more than 4,000 varieties of native potatoes and over 180 wild potato species (**IPC, 2016**).

The hardiness of potato makes it possible for it to grow from sea level up to an altitude of 4700 meters above mean sea level, in all kinds of environmental conditions. It is also an extremely efficient crop as one hectare of potato can yield two to four times the food quantity of grain crops. In addition, it produces more food per unit of water than any other major crop and is up to seven times more efficient in using water than cereals (**IPC, 2016**).

Potato has been widely accepted throughout the world as a staple food and is available in many forms yet most of the consumers are unaware of the healthful attributes of the tubers. It has greater dry matter and protein per unit area as compared with the cereals (**Bamberg and Del Rio, 2005**).

Cooked potatoes are a good dietary source of carbohydrates, which makes about 75% of the total dry matter of the tuber. It produces more carbohydrates, fibres and vitamins per unit area and time than the other major food crops. It is a low energy food and provides 138

Kcal/200 g of boiled potato. It is rich in potassium and phosphorus (**Shekhawat *et al*., 1992**). Starch is the predominant carbohydrate in potatoes and serves as an energy reserve for the plant. Its protein content ranges from 1-1.5% of the fresh weight of tuber (**Ortiz-Medina, 2007**).

Compared with other raw vegetable sources, potatoes are not considered as a good dietary protein source due to their overall low protein content. Lipids are only a tiny fraction of potato weight, amounting to approximately 0.15 g/150 g fresh weight (FW), less than cooked rice (1.95 g) or pasta (0.5 g) (**Priestley, 2006**). The predominant vitamin in potato is vitamin C (ascorbic acid), which ranges in content between 84 to 145 mg per 100 g dry weight depending on the cultivar, planting site and storage conditions (**Augustin, 1975**). Vitamin C is important for iron availability, a mineral that tends to be limiting in the human diet (**Brown, 2008**).

Tuberisation in potato is influenced by environmental conditions, such as temperature, photoperiod and light intensity. Changes in these factors influence the levels of endogenous plant growth regulators (PGR) (**Jackson, 1999**). **Cutter's** (**1992**) model for the role of PGR in potato tuberisation proposes that gibberellins inhibit and abscisic acid promotes tuber induction. Auxins and cytokinins influence tuber size, whereas ethylene inhibits tuber induction *in vivo* or may cause the swelling of stolons without starch in vitro (**Mingo-Castel *et al*., 1976**).

Tuber yields were not affected by exogenous application of BA or IAA, but were reduced by GA_3 (**Corsini *et al*., 1989**). However, IBA is preferred than other growth substances as it has low auxin activity and destroys relatively slowly by auxin degrading enzymes. IBA is persistent in nature. According to **Lovell and Booth** (**1967**), exogenously applied gibberellin stops the growth of preformed tubers by promoting the development of new stolons. At the same time, the length of the internodes and height of the plants increase (**Sharma *et al*., 1998**).

The growth inhibitors daminozide and chlormequat chloride promote tuberisation and significantly reduce the height of potato plants derived from seed tubers (**McIntosh and Bateman, 1979**; **Sharma *et al*., 1998**), but the effect of these inhibitors depends on the genotype, the stage of plant development and the environmental conditions at the time of application (**Sanderson *et al*., 1990**).

Cytokinins are essential for cell division in developing sprouts and the exogenous application of cytokinins to tubers may reduce the duration of tuber dormancy, depending on the physiological age of the tuber (**Coleman, 1987**; **Fernie and Willmitzer, 2001**). Although auxins are essential for sprout growth, they do not appear to affect dormancy (**Hemberg, 1985**; **Wiltshire and Cobb, 1996; Fernie and Willmitzer, 2001**).

By contrast, exogenously applied gibberellins apparently promote the breaking of dormancy of tuber sprouts (**Van Ittersum and Scholte, 1993**) either through the activation of enzymes involved in carbohydrate metabolism or by the induction of changes in intracellular compartmentation (**Wiltshire and Cobb, 1996**).

Therefore, the present study was under taken to study the response of potato to different plant growth regulators for vegetative, tuber yield and quality characters and to determine optimum concentration of plant growth regulators for improving the tuber yield.

PROBLEM BACKGROUND

Since potato is a major vegetable crop, which is also widely used in processing industry. So, with the help of data collected and analysed from this experiment, the response to the application of different concentrations of three different growth regulators on the vegetative characters, quality attributes and yield of potato tubers can be determined, which will ultimately help in increasing the productivity of this crop.

REVIEW OF LITERATURE

Racca and Tizio (**1968**) found that before tuberization the shoots contained large quantities of gibberellin-like substances which decreased after tuberization and it is suggested that these substances are of importance in the control of tuberization. Also, GA_3 leads to smaller tubers resulting in increased bud numbers and stolons by removing of apical dominance. Foliar application of GA_3 (5 and 10 ppm) increased the length of stems and stolons, and decreased the tuber fertility, but causes elongation of the stolons (**Burton, 1989**; **Chapman, 2006**).

Environmental factors especially day length and temperature play a major role in tuber initiation. Although some other factors are effective on tuber productivity, it was proved that these factors influence by the growth regulatory materials or plant growth regulators (PGR) and especially changing the levels of "endogenous Gibberellins" (**Bielek, 1974**).

Alexopoulos *et al*. (**1979**) showed that when GA_3 was applied to potato it induces dormancy breaking, a reduction in specific weight, a higher rate of respiration and increased weight loss during storage. This is explained by the fact that the effect of this hormone on the removal of apical dominance in potato tubers. This has been also proved previously by **Timm *et al.*** (**1962**) and **Racca and Tizio** (**1968**).

Sillu *et al*. (2012) carried out investigation of plant growth regulators and methods of application on growth and other yield components on potato. 10 treatment combinations comprised of two levels of methods of application viz., M1 (Seed treatment) and M2 (Spray treatment) and five levels of plant growth regulators R1 (control), R2 (GA_3 25 ppm), R3 (GA_3 50 ppm), R4 (IBA 100 ppm) and R5 (IBA 200 ppm). Spray treatment of IBA 200 ppm was effective in maximum germination per cent, growth, number of shoots per plant, days taken for physiological maturity, number of tubers harvested per plant and yield of tuber kg/ha and application of spray of GA_3 50 ppm was superior for minimum days taken for germination and average weight of tuber.

Gibberellin application enhanced shoot emergence, increased shoot height, stems per hill and number of tubers per hill (**Khurana and Pandita, 1987**). Gibberellins show different actions at different concentrations, for example gibberellic acid (GA_3) avoid tuber fertility at high concentration (**Chapman, 2006; Wareing and Jennings, 1980**).

The increase in plant height and total leaf area following GA_3 application early in the growth cycle was similar to that observed in plants grown from seed tubers (**Sharma *et al*., 1998**). Spraying of GA_3 40 mg/l at flowering stage recorded the maximum number of leaves, leaf area, leaf area index and dry weight of plant at harvest stage (**Satodiya *et al*., 2012**). GA_3 increased shoot extension, leaf area, number of leaves, stolen and tubers but decreased dry matter of stem, leaf and tuber, IAA (**Kumar *et al*., 1981**).

Auxins promote cell enlargement in isolated plant tissues, but the exogenous application of IAA to whole plants does not affect growth due to an increase in the activity of IAA peroxidase, especially in the roots (**Bandurski *et al*., 1995**). Plant growth regulator affects the physiology of plant growth and influence the natural rhythm of a plant.

(IAA) and (GA_3) can manipulate a variety of growth and developmental phenomena in various crops. IAA has been found to increase the plant height; number of leaves per plant, GA stimulated stem elongation increase dry matter accumulation (**Hore *et al*., 1988**). IAA and GA_3 can increase fruit size with consequent enhancement in seed yield. It also increases the flowering and fruit set (**Gurdev and Saxena, 1991**).

Although **Cutter** (**1992**) indicated that the exogenous application of NAA or 2,4-D may increase tuber size in plants derived from seed tubers, auxins and cytokinins did not affect tuberisation in potato plants derived from TPS. The application of IBA recorded its superiority over other plant growth regulators for plant height, number of branches and number of leaves; therefore, it resulted in highest dry weight of foliage (**Bhatia *et al*., 1992**).

PROPOSED RESEARCH OBJECTIVES

1. To evaluate the response and performance of potato tubers to the foliar application of different plant growth regulators with varying concentrations
2. To compare the vegetative characters and yield of different treatments with control
3. To evaluate the quality attributes of different treatments

PROPOSED RESEARCH METHODOLOGY

Experimental Site: Lovely Professional University Agriculture Farm.

Treatment Details: Ten different treatment combinations of plant growth regulators (IAA, GA_3, Kinetin) along with control will be applied in potato variety in a Randomized Block Design with three replications.

Layout of the Experiment:

Variety	: Kufri Pukhraj
Design	: RBD (Randomized Block Design)
Treatments	: 10
Number of replications	: 3
Plot size	: 2 m x 2 m = 4 m^2
Total number of plots	: 30
Total Area	: 193.5 m^2
Spacing	: 60 x 40 cm
Seed rate	: 15-20 q/ha
Sowing time	: Oct-Nov

Observations to be recorded:

1. Emergence percentage (%)
2. Plant height (cm)
3. Leaf area index
4. Number of haulms/hill
5. Number of compound leaves/hill
6. Total number of tubers /hill
7. Average weight of tubers/hill (g)

8. Length of tubers (cm)

9. Harvest index (%)

10. Total yield (t/ha)

11. Quality attributes

   a. Dry matter content (%)

   b. Total soluble solid (^oB)

   c. Specific gravity (g/cm^3)

Treatment Details:

T_1 –50 ppm IAA

T_2 – 100 ppm IAA

T_3 – 150 ppm IAA

T_4 – 50 ppm Kinetin

T_5 – 100 ppm Kinetin

T_6 – 150 ppm Kinetin

T_7 – 25 ppm GA_3

T_8 – 50 ppm GA_3

T_9 – 75 ppm GA_3

T_{10} – Control

Materials required:

1. FYM = 20 to 25 t/ha (400 kg FYM/193.5 m^2)
2. NPK = 100-150 kg:80-100 kg:80-100 kg/ha
3. Vermicompost = 2 t/ha (40 kg/193.5 m^2)
4. IAA
5. Kinetin
6. GA_3

EXPECTED RESEARCH OUTCOMES

The experiment will be helpful in determining which growth regulator applied at which stage of plant and at what concentration will enhance the vegetative characters, quality attributes and yield of potato tubers. From the results that will be obtained from this study, we can include the use of growth regulators at a defined concentration in potato at commercial level to boost up the potato productivity per unit area.

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