Synopsis of Thesis/Dissertation Report Work of Post-Graduate Student

M.Sc. - Agri. Horticulture (Vegetable Science)

EFFECT OF CALCIUM AND MAGNESIUM NUTRITION ON GROWTH, TUBER YIELD AND LATE BLIGHT (PHYTOPHTHORA INFESTANS) INFESTATION IN POTATO (SOLANUM TUBEROSUM L.)

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CERTIFICATE

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INTRODUCTION

Potato (Solanum tuberosum)- the fifth most important crop worldwide, after wheat, corn, rice and sugar cane (Mann 2011), is a member of Solanaceae family and comprising basic chromosome number (x = 12) (Bonierbale et al. 1988). It has poor crossability due to their ploidy (Kuhl et al. 2001). It is consumed for energy (approx. 350 kJ/l00g), especially vitamin C (Burton 1983). In Peru, around 8000 to 5000 BC, potato originated and spread across globe (Spooner 2005).

Worldwide, approximately 341 million tons of potatoes are produced every year from around 49 million acres. The China produces between 66 and 71 tons being grown each year ranking top on the list followed by Russia and India. World average yields (7.6 ton/acre) varies across developed (17.8 ton/acre) and developing nations. Although fresh potato consumption in developed nations has been stagnant but still processed products seems occupying space and acceptance, among consumers on large scale. In tropics, better productivity could be achieved using advanced technology as of developed farming (Burton 1983). On contrary, elevation in fresh potato demand among consumers of developing regions is observed (World Potato Production, n.d.).

Historically, potato entered India via Portugal in seventeenth century. Today, India ranks as world's second largest potato producing nation, with production of around 43417.05 MT in 2016 (www.indiastat.com/). In India, majorly potato is cultivated in Uttar Pradesh, West Bengal, Punjab, Karnataka, Assam and Madhya Pradesh.

In Punjab state, Jalandhar leads the Hoshiarpur followed by Ludhiana and Patiala constitute the major potato producing belts. Potato is cultivated on more than 89993 ha area with annual production of 22.6 Lakh tonnes in the Punjab (Dept. of Horticulture, Punjab 2014-15), most of which is meant for seed production. The potato seed industry and associated statutory bodies require a reliable means of cultivar identification that can be applied routinely to large numbers of samples. It becomes difficult as over 1000 potato cultivars exist, globally (Chase 1989) and significant new cultivars are registering annually (Prevost and Wilkinson 1999).

In Punjab, popular potato varieties include K. Pukhraj, K. Jyoti, K. Himalni. Among disastrous biotic stress, potato is severely attacked by the *Phytophthora infestans* (Late blight) and can result into crop failures, if appropriate control measures are not adopted, in a short period, upto 80% yield loss in epidemic years. During past years, epidemics of the disease have appeared in 1985-86, 1989-90, 1992-93, 1997-98, 2006-07 and recently during 2007-08 season (Potato cultivation in Punjab, n.d.)

Phytophthora infestans caused late blight is widely studied since the famous Irish famine occurred resulting shortage of the staple food, potato, causing millions of deaths and displacements of humans. (Cooke et al. 1998, Mizubuti and Fry 2006).

PROBLEM BACKGROUND

- Late blight is the major disease of potato
- Appropriate doze of calcium and magnesium for more plant vigor
- Effect of calcium and magnesium nutrition on tuber yield
- Use of non- chemical methods for controlling late blight of potato.

REVIEW OF LITERATURE

Effect of late blight on growth and tuber yield of potato

Rotem *et al.* (1983), stated that the average healthy haulm area during the growth of potatoes attacked by *Phytophthora infestans* and the subsequent yield of tubers, both of sprayed and non-sprayed tubers. The severity of blight at the end of the seasons varied from about 10% in a crop sprayed with fungicide to 100% in a non-sprayed one. (Paul E. Waggoner and Richard D. Berger, 1986).

Haverkort and Bicamumpaka (1986) experimented screening programme on potato late blight using large no. of genotypes, whose production were directly dependent on the radiation intercepted by the crop. With the use of contact and systematic fungicides, the amount of total intercepted radiation was measured. The genotypes that started forming tubers at a fairly level of intercepted radiation were, comparatively bolted the effect on tuber yield from the infection of late blight on foliage.

Bouws and Finc (2008) studied the effects of intercropping or strip cropping on potatoes with cereals and also perpendicular to wind direction on the severity of late blight in Germany. Disease was significantly reduced by 9-20% and 4-12% in the strip cropping In strip-cropped potatoes, disease was significantly reduced by 9–20% and 4–12%, respectively, compared to pure stands of potato, with the greatest reductions in plots planted perpendicular to the wind and neighboured by grass-clover. The utmost important factors of disease reduction were inoculum loss outside plots and barrier effects of neighbouring non-potato hosts. Nutrient limitation appeared to be more important than disease in reducing yields. Strip intercropping might be a useful component in an overall management strategy to reduce incoming late blight inoculum.

Effect of Calcium on growth and tuber yield of potato

Collier (1978) conducted an experiment on potato plants grown in vermiculite and supply 0, 1 or 3 mm $cacl_2$ solution which develops brown necrotic wounds of internal rust spot. He observed that plants supplied with 9 and 27 mm $cacl_2$ solution do not show any symptoms and have good concentration of calcium in tubers and plant dry matter. It is noted that internal rust spot is a major physiological disorder related with low content of calcium in the infected tubers.

Tzeng (1986) observed that Ca content in peel of potato tuber can negatively impact the occurrence of internal brown spot and sub apical necrosis of tubers ($r = -0.754$ and $r = -0.792$, respectively). They noted the concentration of calcium at initial stage (5.0% to 42.5%) and after 7 months of storage (0.226% to 0.130%), when tubers are attacked with internal brown spot. Sub-apical necrosis of potato tubers might be noted as secondary deficiency symptom of calcium in tubers.

Simmon and Kelling (1987) found that in low CEC sandy soils, where Ca content in soil is very low than yield of potato tubers was not good on quality and quantity basis in Wisconsin. In 1985 six doses of calcium was added (0, 56, 112, 168, 224, and 336 kg Ca ha^{-1}) in the form of $CaSO_4$ in the hilly plot and in 1984, in the Plainfield soil, 3 doses of $Ca(NO_3)_2$ (0, 84, and 168 kg Ca ha_{-1}) were added as side dressing. Than they factorially evaluated the efficiency of $Ca(NO_3)_2$as a combined source of Ca and N. Effect of $CaSO_4$ was not found in total yield, but 100 kg Ca ha^{-1} in Calcium nitrate form increased total yield 3.6 Mg ha^{-1}. Use of 100 kg Ca ha^{-1} in $Ca(NO_3)_2$ form in combination with Calcium sulphate gives more efficiency than $CaSO_4$ alone.

Clough (1994) during the studies on potato for 3-years he found the response of potato Cv.`Atlantic' (1989), `Frontier' (1990-91), and `Russets Burbank' (1989-91) potato (*Solanum tuberosum* L.) to rate and time of Ca fertilizer application. Ca was applied before sowing at 0, 90, 180, and 270 kg·ha-1 as Calcium sulphate and side-dressing at dose of 0, 34, and 68 kg·ha-1 as Ca(NO3)2. Pre-plant application of Ca fertilization increased soil Calcium content each year. Calcium fertilization did not impact the potato tuber yield or size grade distribution system. In 1990, IBS attack in `Frontier' was controlled by application of ca as preplant fertigation and side-dressing Ca application. In 1991, after storage for 4 months at 7°C, effect and percentage of IBS attacked tubers were reduced due to pre-sowing and side-dressing Ca fertilization. Brown core of tubers in `Russet Burbank' was decreased due application of side-dressed with high calcium rate. In 1990, `Russet Burbank' french-fry colour improved as preplant Ca rate increased.

(Maier *et* al;2002) do an experiment in which he conducted three glasshouses, using light soils, to find the impact of nitrogen (N) and calcitic lime on soil pH level, potato tuber yield, plant leaf chemical composition and cadmium (Cd) concentration in tubers of potato (*Solanum tuberosum* L.) cultivars Russets Burbank and Atlantic. The N fertilizers applied were calcium nitrate, ammonium nitrate, urea, and ammonium sulphate. Rate of calcitic lime was ranged from 0 to 20 t ha^{-1}. Liming directly reduce tuber cadmium (Cd) content in all experiments. When calcitic lime was not applied, and calcium nitrate is used as N source significantly increase the cadmium concentration in potato tubers than ammonium sulphate. Ca added in this fertilizer increases Cd uptake by plants through displacement of Cadmium from soil surfaces.

(Park *et* al; 2005) recorded that the increased Ca content in potatoes may increase the production with good quality tubers and storage life. Altering Ca level in potato tubers through genetic modifications has not been addressed previously. They show that potato tubers which expresses Arabidopsis H+/Ca2+ transporter sCAX1 contains up to 3-times more Calcium as compare wild-type. The increased Ca content was equally distributed in whole tuber. Due to these transgenic plants Ca intake in population is increased. This research shows the first attempt to use BT to increase the Calcium concentration of potatoes.

Effect of magnesium on growth and tuber yield of potato

(Chucka 1934) Magnesium known as an essential mineral for plant growth and development. It is assumed that in India all soils consist good amount of magnesium to fulfil the requirements of all agricultural crops. Soluble carriers in magnesium fertilizers are more impactive as compare to dolomitic limestone to reduce magnesium deficiency. In Aroostook conditions the additional high-calcium containing limestone to potato results into reduction of the potato yield. High potato yield is taken by application of magnesium as top dressing or in the form of fertigation on fields shows deficiency symptoms. It is noted that the Mg may be absorbed by the leaves of potato plants. In the problematic soils where Mg deficiency will take place, it is preventing by application of dolomitic limestone.

(Bonde et al; 1934) found that potato plants which are grown in soil deficient in Mg develop a definite disease. The disease may be noted as stunting of plant height, reduction in chlorophyll of leaves, leaf shedding, early dying and yield reduction. It was observed that addition of Mg to soil would check this problem. Magnesium-lime is also used in Bordeaux mixture.

(Knoblauch and Odland 1934) observed that magnesium deficiency is very severe in acidic soils and in those soils where chemical fertilizers are used in huge amount from many years. If magnesium is supplied to various P carriers, under acidic soil conditions, than it increases the potato yield. In one field trail yield was increased 100 times due to application of magnesium in that field. All forms of Mg were found as equally effective when 25 pounds of MgO/acre is applied to all fields. In acidic-soils it is recommended that Mg limestone supplyies 25 to 35 pounds of MgO/ acre by mix it with fertilizer or top-dressing of Mg limestone in field.

(Sawyer and Dally 1966) recorded that 40 to 60 lb. level of MgO equivalent application of fertilizers shows adequate results in maintaining 50 to 60 lb magnesium in soil and building up in lower soil level on Long Island. A new magnesium fertilizer, pulverized serpentine was as good as 50/50 mixture at the recommended level of magnesium oxide equivalent and shows no harmful effects from high level of dose. After the results of two years research it was not shown that, why pulverized serpentine is not used at as source of magnesium when there was no any problem related to compatibility to soil and it was also economically fit.

PURPOSED RESEARCH OBJECTIVES

- Effect of calcium and magnesium nutrition on vegetative growth of potato plant
- Effect of calcium and magnesium nutrition on tuber yield
- Effect of calcium and magnesium nutrition on infestation of late blight in potato.

RESERCH METHODOLOGY

Experiment site: - The experiment is conducting at Agricultural Research Farm, Lovely Professional University, Phagwara (Punjab), Latitude 31° N and Longitude 75° E.

Experiment detail: -

Experimental materials

Varieties: - Kufri Jyoti and Kufri Chandramukhi

Nutrients used: - Calcium nitrate and Magnesium sulphate.

Experimental layout and design

Design – Randomized Complete Block Design (RCBD)

Treatments- 9

Replications- 3

Spacing- 60*45 cm

TREATMENTS	NUTRIENT LEVEL
T1	CaNo3(0.5%)
T2	CaNo3(1%)
T3	CaNo3(2%)
T4	MgSo4(0.5)%

T5	MgSo4(1%)
T6	MgSo4(2%)
T7	CaNo3+MgSo4(1% both)
T8	CaNo3+MgSo4(2% both)
T9	Control

Observations

- Emergence percentage
- Plant height
- Leaf area index
- Number of shoots/plant
- Foliage weight/plant(g)
- Numbers of tubers/plant
- Dry matter content
- TSS in tubers
- Tuber weight(g)
- Tuber length(cm)
- Tuber yield/plant (g)
- Total tuber yield (q/ha)
- Ca content in tuber
- Mg content in tuber
- Severity of Late Blight Disease
- Marketable / Processable (>35 g tubers) tuber yield (q/ha)

EXPECTED RESULT OUTCOME

- ✓ More calcium content in tuber
- ✓ More magnesium content in tuber
- ✓ Less incidence of late blight disease
- ✓ More vegetative growth of plant
- ✓ More yield
- ✓ Production of good quality of tubers.

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