Research and Development of Radiation Processing of Polysaccharide for Agricultural Sector in Myanmar

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Objectives

1. To explore research on production of super water absorbents and plant growth promoter using polysaccharides and gamma radiation.
2. To build up productive, profitable and sustainable agricultural systems using these products.

I. Introduction

The Republic of the Union of Myanmar is the largest country of South-East Asia located between 9°32′ N & 28°31′ N Latitude and 92°10′ E & 101°11′ E Longitude. Myanmar is situated in the western part of the South-East Asia, bordering the Bay of Bengal and the Andaman Sea with its 2400 km long coast line. It is potentially rich with marine natural resources and so brown seaweeds are abundant in coastal area. Myanmar is an agricultural-based country in which rice is the main staple food and rice straw is available. As a tropical agricultural country, raw materials for starch are also abundantly found in Myanmar. Myanmar has a tropical climate with three seasons namely Rainy (mid-May to mid-October), winter (mid-October to mid-February) and summer (mid-February to mid-May). Dry regions depend on rainy reason for water resources. More food production is needed for increasing global population. Fertilizers and water are two factors which put limitations on the agricultural products. Therefore, improving the utilization of water resources and nutritive fertilizers are of a high importance.

Over the past decades of years, chemical fertilizers have been the primary means of enhancing soil fertility. They contain no humus so that they cannot improve the soil texture. For long term usage, the crops do not yield as much as expected due to the problem of declining soil fertility. Moreover, chemical fertilizers might have some harmful effects such as High cost and Environmental pollution (air and water). In recent years, natural polymers are being explored for many applications because of their unique characteristics such as easy availability, biocompatibility and biodegradability. To fulfil the major needs for improving safe agricultural productivity in the country, and to apply radiation technology for useful products in agriculture, current research is based on radiation processing of polysaccharide for production of super water absorbents and plant growth promoter (liquid fertilizer) using Gamma Radiation. In this research, corn starch and rice straw were used for production of super water absorbents and brown seaweed for plant growth promoter.

II. Experimental

Materials

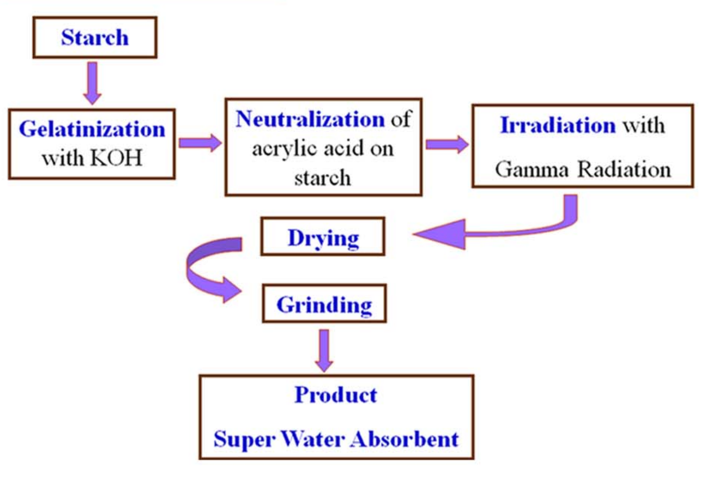

Corn Starch


Brown Seaweed

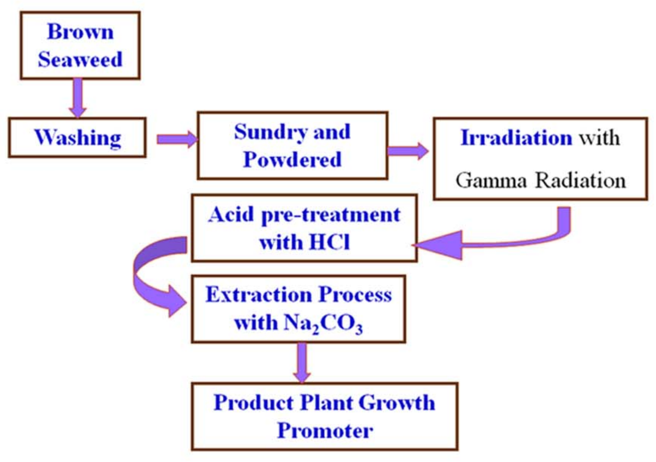

Rice Straw


Gamma Chamber

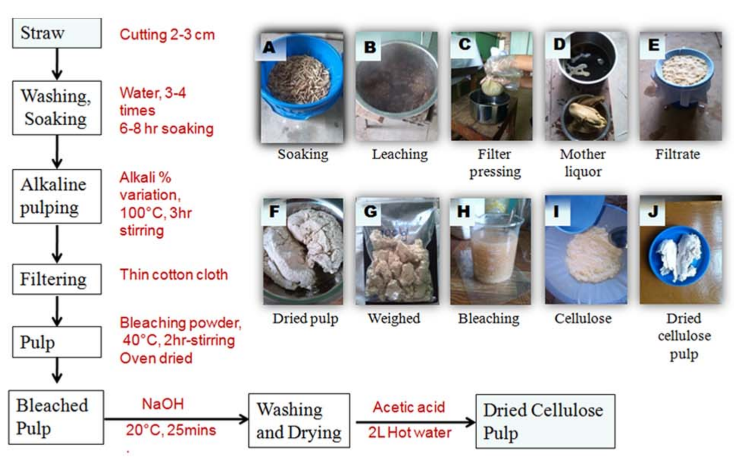
Procedures

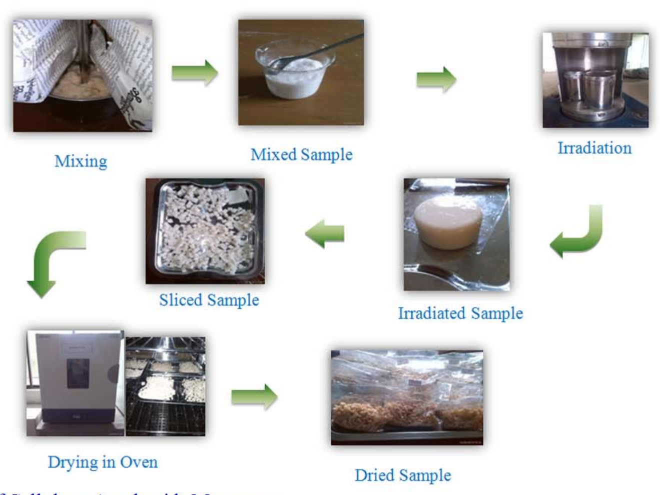


Schematic Diagram of Preparation of Super Water Absorbent



Schematic Diagram of Preparation of Plant Growth Promoter

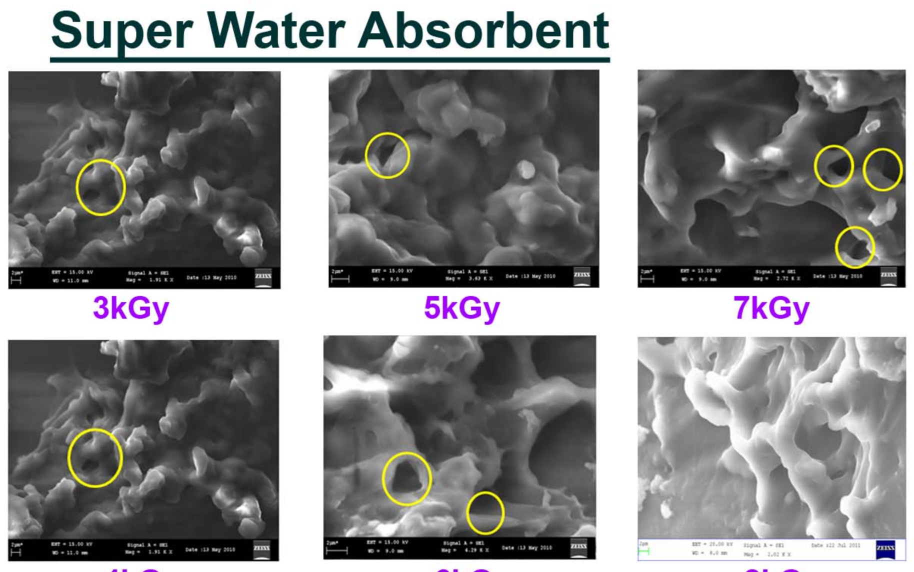


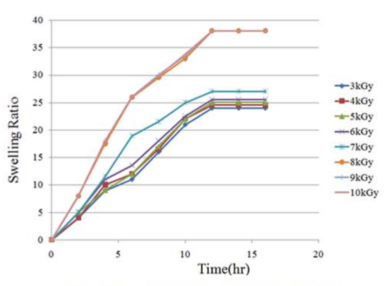


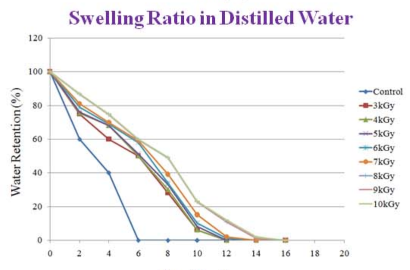
Flow Diagram of Pulping and Radiation Grafting Process of Cellulose-Acrylamide Monomer

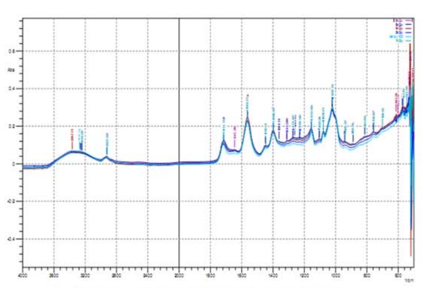
III. Analytical Results

Super Water Absorbent

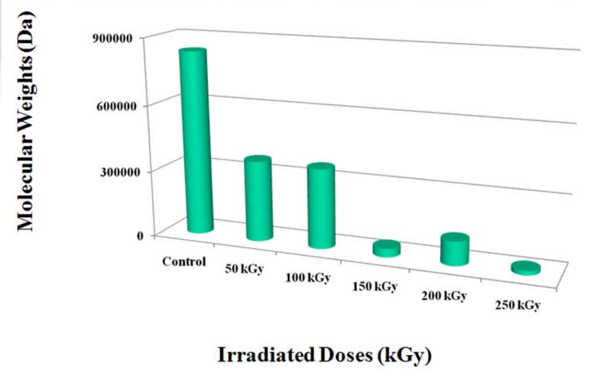



Swelling Ratio in Distilled Water

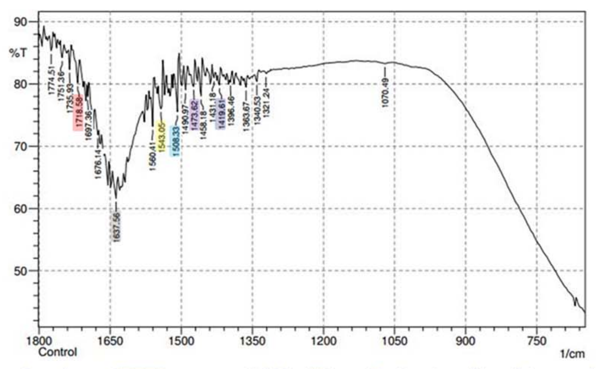

Water Retention Capacity in Soil


IR Spectrum of Irradiated SWAs

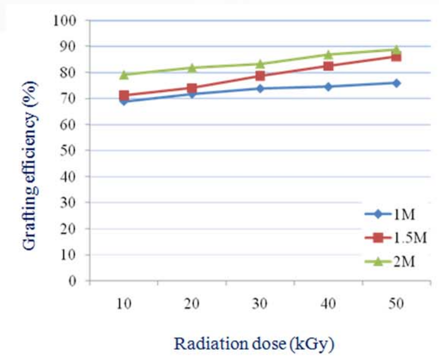
Plant Growth Promoter



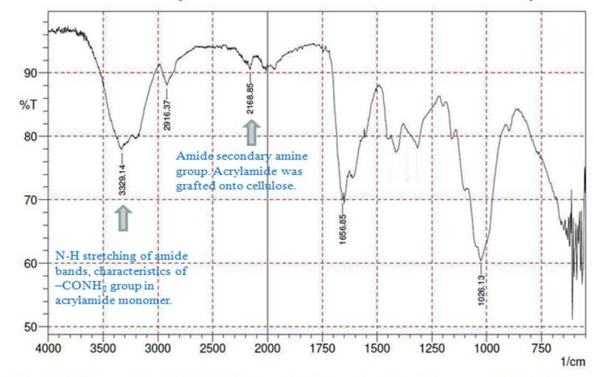
The relationship between viscosities of seaweed solution and their molecular weights for the various irradiation doses.

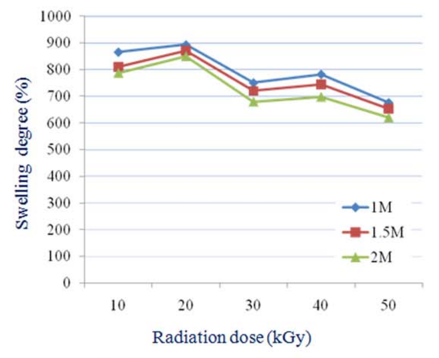

Overlays of FTIR spectra (1800–650 cm^{-1}) of unirradiated (control) SLF showing changes in relative intensities of the bands

Cellulose-Acrylamide Monomer



Effect of Radiation Dose on Grafting Efficiency


The FTIR spectra (4000–550 cm^{-1}) of grafted cellulose which is formed by using 1.5M monomer concentration at 10 kGy



Effect of Radiation Dose on Swelling Efficiency

IV. Field Test Results

Super Water Absorbent

Treatment	Germination (%)	Seedling Survival (%)
Control	33.33	0
3kGy	60	33.33
4kGy	60	33.33
5kGy	66.66	33.33
6kGy	66.66	40
7kGy	73.33	66.66
8kGy	93.33	86.66

Effect of Radiation on Germination and Survival Tests


Germination and Seedling Survival Test on Tomato Plant


After 15days


After 45days

Treatment	Flowery Date	Fruitful Date	Yield/ Plant(g)
Control	30.12.11	11.1.12	302.2
3kGy	5.10. 11	14.10.11	500.2
4kGy	16.10. 11	29.10.11	424.9
5kGy	10.10. 11	22.10.11	462.6
6kGy	4.10. 11	16.10.11	520.6
7kGy	2.10. 11	13.10.11	606.2
8kGy	26.9. 11	3.10.11	912.2

Effect of Radiation on Yield of Tomato Fruits

Plant Growth Promoter


Sowing after 62 days


Sowing after 90 days

Treatments (Doses at kGy and Concentrations)	First Chickpea Field Trial	Second Chickpea Field Trial
50 (5000 ppm)		341
50 (6700 ppm)	279	350
50 (8400 ppm)		354
100 (5000 ppm)		337
100 (6700 ppm)	277	355
100 (8400 ppm)		357
150 (5000 ppm)		344
150 (6700 ppm)	273	354
150 (8400 ppm)		362
200 (5000 ppm)		331
200 (6700 ppm)	292	382
200 (8400 ppm)		398

Yield Comparison of Two Trials

V. Discussion and Conclusion

A. Preparation of Super Water Absorbent from Starch

FT-IR spectrum confirmed the position of molecular groups in grafted polymer SWA. Increasing of radiation dose on SWA gives greater pore size as shown in SEM figures. Moreover, swelling ratio and water retention capacity of SWAs were increased with radiation dose. In addition, from the field test it can be found that 8kGy gave the highest values. Therefore, it can be concluded that SWA with dose of 8kGy is the optimal condition for our research.

B. Preparation of Plant growth Promoter from brown Seaweed

FT-IR spectrum confirmed the position of molecular groups of Seaweed Liquid Fertilizer (SLF). Gamma –Irradiated seaweed showed rapid decrease in molecular and it is clear that radicals produced by irradiation of water could benefit to depolymerization of natural polymer (Brown Seaweed). Field tests showed seaweed fertilizer with dose of 200kGy gave the highest yield results for both trial tests. Moreover, it was found that concentration of 6700 ppm was the best amount for chicken pea trial. So, it can be concluded that concentration of 67000 ppm produced by dose of 200kGy is the optimal condition for our tests.

C. Preparation of Super Water Absorbent from Rice Straw Cellulose

FT-IR spectrum confirmed the position of molecular groups in grafted polymer SWA. By varying of temperature and concentration of reagents, cellulose could be produced from rice straw. It was confirmed by colour, yield and SEM. Grafting efficiency increased with increasing radiation dose. Swelling increased at initial doses (10-20 kGy) but decreased from 20-30 kGy. Radiation enhances number of free radicals on cellulose chain to form more crosslink which reduce free volume for swelling. Grafting efficiency increased with increasing monomer concentration. Higher in monomer concentration made free radicals come closer and tends to form more crosslink that led to decrement in swelling. Therefore, it can be concluded that it is still needed to do research on variation of monomer concentration, radiation dose and other condition for mixing thoroughly to obtain the good SWA.