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Role of organic amendments on growth, yield, quality, rotting and biochemical changes in potato (*Solanum tuberosum* L.).

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The aim of The study is to keep environment clean, maintaining the ecological balance and providing stability to the production level without polluting soil, water and air. Organic farming improved the quality of tubers and increased the production, starch and reducing sugar content but reduces the storage loss, tuber rot and non reducing sugar content. The maximum number of grade I, II, III and IV tuber (>75, 51-75, 26-50 and 0-25g) was found in T_4 treatment with the value of (130.25, 297.75, 270.25 and 347.75) respectively. Maximum number of tubers was also recorded in T_4 treatment showing 1046 tubers against 496 in control. The highest tubers yield with 43.61 t/ha were recorded in T_4 treatment. Where as T_1 treatment gives lowest tuber yield as 26.69 t/ha. The tuber weight loss was found maximum (29.70%) in T_1 treatment while, minimum 24.10 per cent in T4 treatment after 120 days of storage. The minimum tuber rottage 4.50 per cent was found in T_4 treatment while maximum 9.50 per cent found in T_1 treatment after 120 days of ambient storage condition. Biochemical analysis of organic grown tuber revealed that maximum amount of starch (16.06%) and reducing sugar (184.76mg/100g) and total sugar (273.12mg/100g) was found in T_4 treatment where as non reducing sugar was maximum found in diseased tubers with the value of (91.98 mg/100g) in T_5 treatment.

Key words : Organic amendment, tuber size, yield, rotting

INTRODUCTION

Organic farming is an Agricultural system which aims at utilization of the land in a way that the soil is kept dynamic with living activities and in good health, at the same time keeping the environment clean, maintaining the ecological balance and providing stability to the production level without polluting soil, water and air. This method is self-sufficient, self-dependent and self-reliant as compared to modern chemical farming. Organic farming envisages a comprehensive management approach to improve the health and the underlying productivity of the soil. In a healthy soil, the biotic and abiotic components covering organic matter improve soil life, mineral particles, soil air and soil moisture in a state of dynamic equilibrium and regulates the eco-system process in mutual harmony by complementing each other. If the soil is healthy and living, then the insect pest and disease problems are also controlled by nature. A number of fungal and bacterial species can also be used to suppress the population of plant pathogens (Gildemacher *et al.*, 2009, Rauf *et al.* 2007, Menon, 2004). Presently, farmers are growing organic food using alternative sources of fertilizers and pesticides. Microorganisms with the ability to suppress plant pathogenic fungi and insect pests are ptentially important alternatives to chemical pesticides. It was hypothesized that some of the alternatives have an ability to suppress the growth of disease causing fungi and bacteria. Organically grown crops produces better food quality that traditionally grown crops using chemical fertilizer and pesticides. Bio-dynmics build up on established methods of sustainable agriculture where in soil and plants are treated with specially fermented herbal preparations and composts that enhance soil organic process to produce toxin free, healthy plant and seeds. Keeping in view the present investigation were under taken to find out the role of organic amendments on total number of tuber, tuber size ,crop yield, weight loss, rotting and biochemical changes in potato.

MATERIALS AND METHODS

The experiment was conducted during Rabi season 2006-07 at Main Experiment Station and Department of Plant Pathology, N.D. University of Agriculture & Technology Faizabad. The entire laboratory experiments such as weight loss, rotting, and biochemical changes etc. were conducted in the Department of Plant Pathology and Department of Biochemistry.

Land preparation

Role of organic amendments on total numbers of tuber, tuber size, crop yield and loss were recorded through field experiment. The necessary irrigation of plot was done and field was again ploughed twice with cultivator followed by planking in order to break the clods as well as to make the soil well pulverized. Besides, all the weeds stubble and other grasses were also removed manually. Then the soil was treated accordingly as follows :-

T_1	Only incorporation of Crop residues in soil, serve as control.
T_2	T_1 + Tuber treatment with Biofertilizers (Azatobactor + phosphobacteria 200g each for 25kg of tuber)
T_3	T_2 + foliar spray with Biodynamic @62.5 g/ha.
T_4	T_2+ FYM@20 tones/ha.
T_5	T_1+ FYM@20 tones/ha.

Tuber treatment with Biofertilizers

The solution of jaggary was used for seed treatment with Biofertilizers. It was prepared by dissolving 100g of jaggary in one litre of water, 200 g each of *Azatobactor* and *Phosphobacteria* were added to this solution. Thus prepared solution was sprayed on the tubers and mixed thoroughly with the hands to obtain uniform coating. Treated tubers were kept in shade for drying. After drying the tubers were planted in experimental field immediately.

Biodynamics solution preparation

The solution was prepared by dissolving one gram of BD-501 in 13.5 liters of water and sprayed on the leaves in the form of 'mist' before sunrise at plant emergence stage (20 days after planting).

Sowing, cultural practices and harvesting

The seed tubers of potato were planted in prepared plots size 3.6 x 3.6m at a spacing of 60 x 20 cm and covered with soil to make the ridges. Hand weeding was done in order to reduce the major population of weeds. Irrigations were applied by tube well at fort nightly interval. Earthling was done at 30 days after planting of tubers with the help of Kudal. Four replications were kept for each treatment the crop was harvested after days of sowing. The total number of tubers in different grades per plot and tuber yield per plot and per hectare was recorded.

Post-harvest study of potato

Twenty kilograms (containing five kg of each replication) tubers of each treatment were stored inside the laboratory under ambient conditions for 120 days to study the periodic weight loss and rottage of tuber in various treatments. Observations were recorded on post harvest rotting of potato starting from date of storage at 15 days periodic intervals up to 120 days of storage. One hundred tubers from each replication of the treatment were randomly selected to observe per cent tuber infection. The data were calculated by using following formula:

$$\% \text{ tuber infection} = \frac{\text{Number of infected tubers}}{\text{Total number ofpotato tubers}} \times 100$$

Biochemical analysis of potato tubers

The biochemical analysis of the experimental material was carried out in the laboratory, Department of Biochemistry to determine various biochemical parameters.

Starch

The estimation of starch was done method ascending by Mecreddy and Hassid, (1949).

Sugar content

Three type of sugar viz. reducing sugar, non-reducing sugar and total sugar were estimated separately using different methods.

Extraction of sugar

Before extraction of sugar samples were dried at

70°C for 6-8 hours. Exactly 100 mg of oven dried sample was transferred in to test tube and added 10 ml alchol (50%). It was then centrifuged at 5000 rpm for 15-20 minutes. Supernatant was collected and evaporated on water bath. Finally 10 ml of CCl_4 was also added and kept for 10 minutes at room temperature. Two layers were formed . The upper layer was collected for estimation of sugar.

(I) *Reducing sugar*

The total reducing sugar was estimated following Nelson-Somogyi method (Pearson 1976). The concentration of reducing sugar was calculated by using standard curve of glucose, which is expressed as mg/100g

(II) *Non - reducing sugar*

Non-reducing Sugar = Total Sugar - reducing Sugar

(III) *Total Sugar*

The total sugar was estimated as proposed by Dubois *et al.* (1956) with slight modification using Phenol reagent method (Swain and Hills, 1959).

RESULTS AND DISCUSSION

The result was obtained from the field and laboratory studies on role of organic amendments on total numbers of tubers, tubers size, crop yield, weight loss, post harvest rotting and biochemical changes in potato. The experimental findings are presented as below.

Role of organic amendments on tuber size, total number of tuber and crop yield

The data presented in the table-1 indicated that all the treatments produced significant number of higher-grade tubers per plot in comparison to control. Maximum number (130.25) of grade I tubers (>75g) was found in T_4 treatment followed by (121.5) T_5 treatment respectively, where as maximum number of grade II (26-50g) grade III tubers (51-75) and grade IV (0-25g) was found in T_4 treatment with the value of 297.75, 270.25 and 347.75, respectively.From the Table 1, it is also clear that the total number of tuber were also recorded in T_4 treatment showing 1046 tubers against 496 in control. The present observation revealed that the total number of tuber per plot is influenced by the effect of organic manure. It was evident from the

Table 1 : Effect of different treatments on total number of tubers per plot and tuber yield per plot and per hectare

Treatment	Number of tubers in different grades (per plot)				Total number of tubers (per plot)	Total tuber yield per plot (kg)	Total tuber yield per ha (Tones)
	>75 g	51-75 g	26-50 g	0-25 g			
T_1	57.75	142.75	127.75	167.75	496.00	35.19	27.15
T_2	110.5	279.5	250.75	323.25	964.00	46.07	35.54
T_3	115.5	284.5	255.25	332.25	987.00	49.07	37.86
T_4	130.25	297.75	270.25	347.75	1046.00	56.33	43.46
T_5	121.5	290.5	261.5	338.756	1012.25	52.18	40.26
CD at 5%	2.174	4.151	2.571	2.119	5.460	2.210	1.63

Table 2 : Effect of different treatments on per cent weight loss in potato tubers during ambient storage conditions

Treatment	Tuber weight (kg)	Tuber weight loss (per cent) at							
		15 DAS	30 DAS	45 DAS	60 DAS	75 DAS	90 DAS	105 DAS	120 DAS
T_1	5.00	7.23 (15.59)	9.23 (17.68)	14.78 (22.60)	17.38 (24.63)	20.20 (26.70)	23.10 (28.72)	25.90 (30.58)	29.70 (33.01)
T_2	5.00	7.20 (15.56)	9.32 (17.76)	13.43 (21.49)	16.40 (23.88)	19.40 (26.12)	21.10 (27.33)	23.75 (29.15)	27.75 (31.78)
T_3	5.00	6.50 (4.76)	9.33 (17.78)	13.70 (21.71)	16.90 (24.27)	19.90 (26.48)	23.50 (28.99)	26.00 (30.64)	25.15 (30.09)
T_4	5.00	7.20 (15.56)	9.64 (18.09)	12.70 (20.87)	15.80 (23.41)	17.90 (25.02)	20.12 (26.64)	22.90 (28.59)	24.12 (29.40)
T_5	5.00	6.00 (14.17)	8.32 (16.76)	12.40 (20.61)	15.00 (22.78)	17.50 (24.72)	20.09 26.62)	22.10 (28.04)	29.00 (33.01)
C.D. at 5%		0.730	0.894	1.264	(1.359)	(1.732)	(1.263)	(1.520)	(2.027)

Table 1 that all the treatments significantly increase the yield of tubers per plot and per hectare. The maximum tubers yield with 43.46 t/ha were recorded in T_4 treatment followed by 40.26 t/ha in T_5 treatment. The T_1 treatment gives tubers yield as 3.35 t/ha, which is the lowest value. Iman and Badawy, (1978) reported that potato tubers when inoculated with *Azotobacter chroococcum* gave significantly higher yield by 8.5-42.6 per cent in comparison to control. Azad and Aslam (1984) observed that the dipping of seed tubers for 20 minutes in suspension of *Azotobacter* increased the yield as compare to dip of tubers for 30,60 minutes. Singh and Pathak (2006) found that effect of FYM alone or in combination *Pseudomonas striata* and phosphorus and reported that highest tubers yield was obtained from combined effect of FYM + *Pseudomonas striata* followed by FYM alone. Indiresh *et al.,* (2003) reported that the response of potato *cv. Kufri Jyoti* to individual and combined inoculation of *Azotobacter chroococcum, Acetobacter diazotrophicus* and *Pseudomonas striata,* showed significant effect on increasing per cent emergence of tubers, number, tuber weight per plant, total tuber yield and marketable tuber yield. Similar findings have been reported earlier also Pandey *et al.,*(2002) and Singh *et al.,* (2010).

Post-harvest study

After harvesting, potato tubers were stored for 120 days separately. The observation on per cent weight loss and rottage were recorded at 15 days intervals starting from date of storage. The data from the table-II indicated that the maximum weight loss 29.70 per cent was recorded in T_1 treatment while, maximum 24.10 per cent in T_4 treatment after 120 days of.storage. From the table - III, it is cleared that the tuber rottage has started from 60 days of storage in all the treatments. The minimum tuber rottage 4.50 per cect was found in T_4 treatment while maximum tuber rottage 9.50 in T_1 treatment after 120 days during ambient storage condition. Escanole *et al.,* (1973) studied that losses caused by rot of potato tubers stored in the field or in cold storage as heaps. Khan *et al.* (1984) studied that the dates to planting influenced the tuber sizes and incidence of tuber rot mainly caused by species of fungi and bacteria under natural storage condition. Ali (1986) reported that rottage at the rate of 2.47% per month in farmer's storage condition while in the storage condition, it was 3.63 per cent after every 6 months. In the private cold storage average monthly rottage was recorded as 0.20% only.. *Fusarium* spp., *Aspergillus* spp., *Penicillium* spp., and *Sclerotium rolfsii* were found to be associated with the rottage of potato in all the cases.

Biochemical analysis

Starch content, total sugar, reducing sugar non-reducing sugar content

The data presented in the table-IV showed that healthy tuber content maximum among the starch than the diseased tubers. Among the treatment, maximum amount of starch (16.06%) was found in T_4 treatment, which was followed by T_5 treatment,

Table 3 : Effect of different treatments on per cent rottage in potato tubers during ambient storage conditions

Treatment	Per cent tuber rottage *(Fusarium + Erwinia spp.)* at				
	60 DAS	75 DAS	90 DAS	105 DAS	120 DAS
T_1 = only incorporation of Crop residues in Soil , serve as control...	2.00 (8.13)	3.50 (10.78)	5.50 (13.56)	7.00 (15.33)	9.50 (17.95)
T_2 = T_1+Tuber treatment with Biofertilizers (Azatobactor + phosphobacteria 200g each for 25kg of tuber)	2.50 (9.09)	4.50 (12.24)	5.50 (13.56)	7.00 (15.33)	7.50 (15.88)
T_3 = T_2 + foliar spray with Biodynamic @ 62.5 g/ha.	2.00 (8.12)	3.00 (9.97)	3.50 (10.78)	4.50 (12.24)	4.50 (12.24)
T_4 = T_2 + FYM @ 20 tones/ha.	1.00 (5.74)	12.00 (20.26)	0.01 (0.40)	3.50 (10.78)	4.50 (12.24)
T_5 = T1 + FYM @ 20 tones / ha.	0.50 (4.50)	0.10 (1.81)	2.00 (8.13)	4.00 (11.53)	5.50 (13.56)
C.D. at 5%	0.433	0.783	0.494	0.99	0.929

Table 4 : Effect of Different treatmen h, total sugar, reducing sugar and non-reducing sugar co$_{nt}$ent in healthy and diseased tubers.

Treatment	Starch content (%)		Reducing sugar content (mg/100g)		Non-reducing sugar content (mg/100g)		Total sugar content (mg/100g)	
	Healthy tuber	Diseased tuber	Healthy tuber	Diseased tuber	Healthy tuber	Diseased tuber	Healthy tuber	Diseased tuber
T_1	13.74	10.66	184.76	182.10	84.41	89.64	270.33	271.74
T_2	14.87	12.05	184.56	180.72	84.77	88.77	269.00	269.49
T_3	14.59	12.31	183.27	180.70	86.24	89.42	266.97	270.12
T_4	16.06	12.39	182.25	181.73	87.23	91.39	265.22	273.12
T_5	15.74	12.19	183.30	180.52	85.38	91.98	266.53	272.50
CD at 5 %	0.886	0.880	1.423	1.530	0.741	1.264	1.532	0.92

showing (15.74%) respectively. Similarly, reducing sugar was found maximum in healthy tubers than diseased tubers where as non-reducing sugar was found maximum in diseased tubers. The maximum, amount of reducing sugar (184.76mg/100g) was founfd in T_1 (control) treatment and total sugar maximum foundf (270.33 mg/100g) was found in T_1 (control) treatment. The non-reducing sugar content was found maximum with value of (87.23mg/100g) in T_4 treatment which was followed by T_3 treatment (86.24mg/100g) of which is also statistically at par. Gangopadhyay and Chatopadhyay, (1976) reported that relative preponderance of reducing sugar, non reducing sugar and acid hydrolyzable polysaccharides in the leaves determines the susceptibility to brown spot. They also concluded that reducing sugars were positively correlated with disease development. Engstrom and Stromberg (1996) also reported sugar content in potato changes during induction of systematic acquired resistance to late blight disease. It has been concluded from the present investigation that organic amendment not only increased the total number of tubers, tuber size, crop yield what also reduced the post harvesting rotting, weight loss during storage. Biochemical analysis of the tuber revealed that increased content of reducing sugar and decreased content of non-reducing sugar was due to the effect of organic amendments. Pandey *et al.* (2008) reported that the mean reducing sugar content decreased from 90 days onwards. All the varieties at all the three stages of maturity contained lower reducing sugar than the prescribed limit (<100mg/ 100g fresh weight).

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