

# Microflora Population and Physico-Chemical Properties of Soil of Potato as Influenced by Oxyfluorfen 23.5%EC

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**Abstract** The effects of Oxyfluorfen 23.5% EC on microflora population and soil physico-chemical properties in potato were investigated over two seasons (2008-9 and 2010-11). The treatments are as follows: oxyfluorfen 23.5%EC @100, 200 and 300 g a.i. ha<sup>-1</sup> as pre-emergence, atrazine @ 1000 g ha<sup>-1</sup> as pre-emergence, pendimethalin @ 1500 g ha<sup>-1</sup> as pre-planting incorporation, farmer practice (hand weeding twice at 15 and 30 DAP) and unweeded control. Among all the treatments, oxyfluorfen@ 300 g a.i. ha<sup>-1</sup> recorded minimum weed population as well as biomass. Potato tuber yield was maximum in oxyfluorfen 23.5%EC @ 300 g a.i. ha<sup>-1</sup> (35.032 t ha<sup>-1</sup>) which is statistically at par with oxyfluorfen 23.5%EC @ 200 g a.i. ha<sup>-1</sup> (34.706 t ha<sup>-1</sup>). Excluding atrazine @ 1000 g ha<sup>-1</sup> and pendimethalin @ 1500 g ha<sup>-1</sup>, no phytotoxicity in potato plants was observed in the herbicidal treatments. Bulk density, water holding capacity, moisture content, soil pH, organic matter content, electrical conductivity, as well as total nitrogen, available phosphorus and available potassium contents were analyzed along with microflora population (total bacteria, actinomycetes and fungi). Soil physico-chemical properties were unchanged. Though, herbicide treatments resulted in decreases in microbial counts initially but with the degradation of applied herbicides within a considerable time, the population even exceeded later than the initial count.

**Keywords** Oxyfluorfen 23.5%EC, Potato, Microflora, Physico-Chemical Properties

serve as an alternative hosts for several insect pest and diseases. Wider spacing, frequent irrigations and liberal use of manures and fertilizers provide favorable conditions for an early start of weeds well before the emergence of potato plant. Singh and Bhan (1999) reported that the presence of weeds throughout the growing season caused 62% reduction in tuber yield. The weed control in potato crop is normally by manual labour. But due to labour problem, alternative herbicidal measures should be evaluated. In India, herbicides have been effectively used to control weeds in agricultural systems. As farmers continue to realize the usefulness of herbicides, larger quantities would be applied to the soil. But the fate of these compounds in the soil is becoming increasingly important since they could be leached down, in which case groundwater is contaminated or if immobile, they would persist on the top soil (Ayansina et al, 2003). These herbicides could then accumulate to toxic levels in the soil and become harmful to microorganisms, plants, wildlife and even man (Amakiri, 1982). The addition of herbicides can cause qualitative and quantitative alterations in the soil microbial populations and their enzyme activities (Min *et al*, 2002; Saeki and Toyota, 2004). Herbicide application may also kill species of bacteria, fungi and protozoa upsetting the balance of pathogens and beneficial organisms and allowing the opportunist, disease causing organisms to become a problem (Kalia and Gupta, 2004). In addition, change in the soil microflora has been listed as one of the possible causes of productivity decline (Reichardt *et al*, 1998). Thus there is a need to study the influence of herbicides on the microflora and their activities in soils.

## 1. Introduction

The most important staple food crop in the world is potato. Potatoes are an economical food; they provide a source of low cost energy to the human diet. There are several constraints in potato production, of which weeds often pose a serious problem. Even though potato plants have robust growing and quick spreading nature but it turns as a weak competitor with weeds. Weeds not only compete with crop plants for nutrients, soil moisture, space and sunlight but also

## 2. Materials and Methods

### 2.1. Study Site

The experiment was conducted with seven treatments replicated thrice with randomized block design. Each plot size was of 5 m × 4 m. The crop was grown during consecutive *rabi* seasons of 2008-9 and 2009-10 at the 'C' Block farm (latitude: 22°57'E, longitude: 88°20'N and

altitude: 9.75 m) of Bidhan Chandra Krishi Viswavidyalaya, Nadia, West Bengal.

## 2.2. Treatments

The treatments are as follows: pre-emergence application of oxyfluorfen @ 100, 200, 300 g ha<sup>-1</sup>, atrazine @ 1000 g ha<sup>-1</sup> and pendimethalin @ 1500 g ha<sup>-1</sup>, farmer practice (hand weeding twice at 15 and 30 days after planting (DAP) and unweeded control. All the herbicides were applied at 5 DAP. Spraying was done with knapsack sprayer with floodjet deflector WFN-040 nozzle with 500 L ha<sup>-1</sup> of water.

## 2.3. Cultivation Methods

The variety used in this experiment was Kufri - Jyoti. The treatments are as follows: pre-emergence application of oxyfluorfen @ 100, 200, 300 g ha<sup>-1</sup>, atrazine @ 1000 g ha<sup>-1</sup> and pendimethalin @ 1500 g ha<sup>-1</sup>, farmer practice (hand weeding twice at 15 and 30 DAP) and unweeded control. All the herbicides were applied at 5 DAP. Potato was sown at the middle of the November of the two consecutive years with the fertilizer dose @ 150:100:100 kg ha<sup>-1</sup> of N, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O. Half of the recommended dose (50 %) of nitrogen @ 150 kg ha<sup>-1</sup> through urea along with full phosphorus through single super phosphate and full potash through muriate of potash, both @ 100 kg ha<sup>-1</sup> were applied as basal during final land preparation. The remaining half N was top dressed at the time of final weeding (tuber bulking starting period) at 30 DAP. One day before sowing, the seeds were treated by using *Trichoderma viridis* @ 4 g kg<sup>-1</sup> of potato seeds besides the *Rhizobium* treatment. The treated seeds were kept under shade for overnight before sowing in the main field and sown at 45 cm x 15 cm spacing in ridge followed by earthing up at 45 DAP.

## 3. Data collection and analysis

### 3.1. Phytotoxicity

Phytotoxicity observation as per CIB guidelines, 1989 (observations on yellowing, stunting, necrosis, leaf injure on tips & leaf surface, wilting, epinasty and hyponasty) was recorded accordingly.

### 3.2. Soil Physic-Chemical Properties-Based Parameters

The physico-chemical properties of experimental soil: texture, pH, organic carbon content, total nitrogen content, available phosphorus content and available potassium content, respectively were estimated by combined glass electrode pH meter method, Walkley and Black's rapid titration method, modified macro Kjeldahl method, Olsen's method and flame photometer method, respectively (Jackson, 1973).

## 3.3. Microbial Population

Soil samples from the experimental plots were collected from the space between the rows at a depth 0–15 cm on different dates *viz.* initial (pretreatment), 3 d after application (DAA), 10 DAA, 30 DAA and 60 DAA of applying treatments. The soil sample from the different places per replicate for the same weed control treatment were pulled together and then requisite composite samples of each treatment were taken for microbial analysis by dilution plating following standard methods. Soil dilutions were prepared in sterile distilled water by constant shaking and plating was done separately in replicates in specific media: Total bacteria (Thornton's agar medium at 10<sup>-6</sup> dilutions), fungi (Martin's rose bengal streptomycin agar medium at 10<sup>-4</sup> dilutions), actinomycetes (Jensen's agar medium at 10<sup>-5</sup> dilutions). The enumeration of the microbial population was done on agar plants containing appropriate media following serial dilution technique and pour plate method (Pramer and Schmidt, 1965): plates were incubated at 30 °C. The counts were taken at the 3<sup>rd</sup> day of incubation.

## 3.4. Statistical Analysis

The data were subjected to statistical analysis by analysis of variance method. The correlation studies were made to reveal the association among the variables in the investigation (Gomez and Gomez, 1984). As the error mean squares of the individual experiments were homogenous, combined analysis over the years were done through unweighted analysis. Here, the interaction between years and treatments were not significant.

## 4. Results

### 4.1. Microflora Population

The population of total bacteria decreased up to 10 DAA as compared to the observation before spraying and then increased for herbicidal treatments (Fig. 1). Farmer practice and control recorded steady but very slow increase of the population. At 60 DAA, herbicidal treatments recorded 62.46 to 125.91% higher population of total bacteria than control.

Among all the microorganisms, fungi was least affected by the treatments and it also contributed the maximum portion of microbial biomass. The populations of fungi decreased on 3 DAA as compared to the observation before spraying of herbicidal treatments. The fungal population decreased after application and then it recovered its population at harvest (Fig. 2). But in case of farmer practice and unweeded control, it showed slow and steady increase of fungi population. Herbicidal treatments recorded 17.34 to 23.12 % higher population of total bacteria than control at 60 DAA.

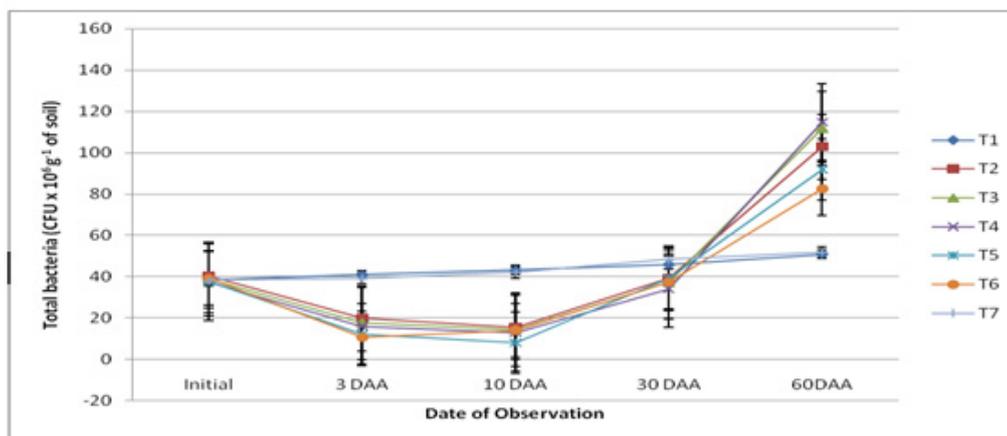


Figure 1. Influence of herbicides on total bacteria (CFU x 10<sup>6</sup> g<sup>-1</sup> of soil) (pooled)

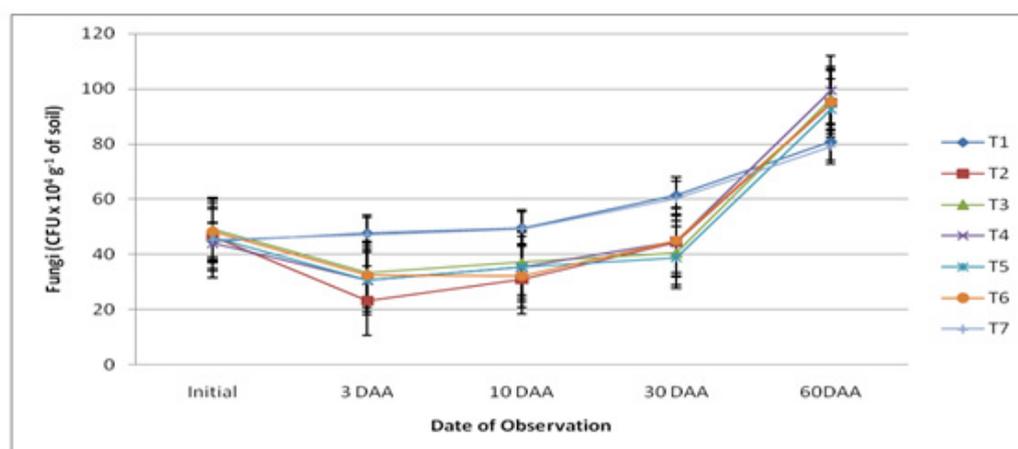


Figure 2. Influence of herbicides on population of Fungi (CFU x 10<sup>4</sup> g<sup>-1</sup> of soil) (pooled)

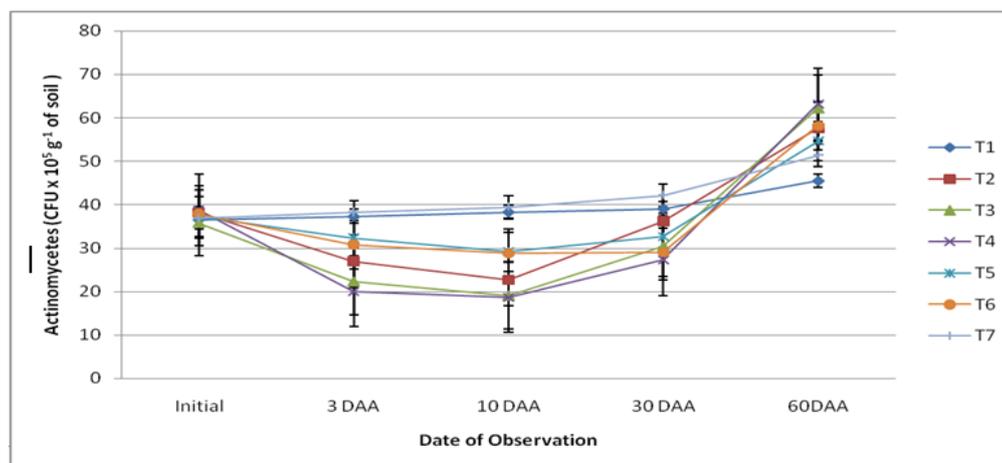


Figure 3. Influence of herbicides on Actinomycetes (CFU x 10<sup>5</sup> g<sup>-1</sup> of soil) (pooled)

The fate of actinomycetes was more or less similar as bacteria. The populations of actinomycetes in the rhizosphere soil of potato decreased on 10 DAA as compared to the observation before spraying and then increased on 30 DAA (Fig. 3) for the herbicidal treatments.

#### 4.2. Physico-Chemical Properties of Soil

#### 4.2.1. Before Application of Treatments

The mean mechanical properties (sand, silt and clay contents; physical properties (bulk density, water holding capacity and moisture content and chemical properties (pH, electrical conductivity, organic carbon, total nitrogen content, available phosphorus ( $P_2O_5$ ) and potash ( $K_2O$ )) of the initial soil of the experimental field are presented in Tables 1 and 2. The soil of the experimental field was sandy loam in texture with a mean soil pH of 6.82 and medium fertility status with low water holding capacity.

**Table 1.** Physical and mechanical properties of the experimental soil before and after treatment (pooled data)

Treatment	Bulk density (g cc <sup>-1</sup> )		Moisture content (%)		Water holding capacity (%)		Sand content (%)		Silt content (%)		Clay content (%)	
	Initial	Final	Initial	Final	Initial	Final	Initial	Final	Initial	Final	Initial	Final
T <sub>1</sub>	1.39	1.41	14.91	14.65	39.06	38.26	58.74	62.78	22.28	23.83	18.98	13.39
T <sub>2</sub>	1.42	1.40	14.56	14.55	39.16	39.40	59.31	62.78	23.27	23.92	17.42	13.30
T <sub>3</sub>	1.44	1.41	14.70	14.85	38.73	38.92	59.63	62.78	23.06	23.83	17.31	13.39
T <sub>4</sub>	1.46	1.42	14.58	15.19	38.67	39.74	58.70	62.00	22.15	22.13	19.15	15.87
T <sub>5</sub>	1.48	1.43	14.78	14.70	38.39	40.34	59.37	62.04	23.38	23.28	17.25	14.68
T <sub>6</sub>	1.46	1.39	14.64	14.93	38.26	38.50	59.49	62.97	22.42	23.47	18.09	13.56
T <sub>7</sub>	1.47	1.41	14.70	14.81	38.71	39.20	59.20	62.56	22.76	23.41	18.04	14.03
LSD (P = 0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
LSD (P = 0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

T<sub>1</sub>- Unweeded control, T<sub>2</sub>- Oxyfluorfen 23.5% EC@ 100 g a.i. ha<sup>-1</sup>, T<sub>3</sub>- Oxyfluorfen 23.5% EC @ 200 g a.i. ha<sup>-1</sup>, T<sub>4</sub>- Oxyfluorfen 23.5% EC @ 300 g a.i. ha<sup>-1</sup>, T<sub>5</sub>- Atrazine @ 1000 g a.i. ha<sup>-1</sup>, T<sub>6</sub>- Pendimethalin @ 1500 g a.i. ha<sup>-1</sup>, T<sub>7</sub>- Farmer practice (Hand weeding twice at 15 and 30 DAP)

**Table 2.** Chemical properties of the experimental soil before treatment (pooled data)

Treatment	pH		EC (dS m <sup>-1</sup> )		Organic carbon (%)		Total nitrogen (%)		Available P <sub>2</sub> O <sub>5</sub> (kg ha <sup>-1</sup> )		Available K <sub>2</sub> O (kg ha <sup>-1</sup> )	
	Initial	Final	Initial	Final	Initial	Final	Initial	Final	Initial	Final	Initial	Final
T <sub>1</sub>	6.81	6.79	0.137	0.141	0.540	0.564	0.0535	0.0560	28.79	30.97	227.88	227.57
T <sub>2</sub>	6.70	6.79	0.143	0.143	0.552	0.566	0.0550	0.0564	29.96	31.17	224.63	229.43
T <sub>3</sub>	6.90	6.82	0.134	0.142	0.534	0.551	0.0576	0.0552	29.86	31.57	223.60	229.74
T <sub>4</sub>	6.87	6.78	0.143	0.142	0.519	0.561	0.0546	0.0560	29.68	31.71	222.44	229.69
T <sub>5</sub>	6.85	6.75	0.145	0.140	0.545	0.563	0.0545	0.0561	29.77	31.79	224.64	227.17
T <sub>6</sub>	6.80	6.74	0.139	0.143	0.542	0.566	0.0552	0.0562	29.42	31.02	229.81	228.58
T <sub>7</sub>	6.84	6.81	0.143	0.143	0.542	0.561	0.0570	0.0570	29.58	31.37	225.50	228.69
LSD (P = 0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

T<sub>1</sub>- Unweeded control, T<sub>2</sub>- Oxyfluorfen 23.5% EC@ 100 g a.i. ha<sup>-1</sup>, T<sub>3</sub>- Oxyfluorfen 23.5% EC @ 200 g a.i. ha<sup>-1</sup>, T<sub>4</sub>- Oxyfluorfen 23.5% EC @ 300 g a.i. ha<sup>-1</sup>, T<sub>5</sub>- Atrazine @ 1000 g a.i. ha<sup>-1</sup>, T<sub>6</sub>- Pendimethalin @ 1500 g a.i. ha<sup>-1</sup>, T<sub>7</sub>- Farmer practice (Hand weeding twice at 15 and 30 DAP)

#### 4.2.2. After Application of Treatments

The bulk density, water holding capacity and moisture content of soil did not vary after harvesting of potato leaves (60 DAA) due to application of herbicide oxyfluorfen 23.5%EC as compared to before application of treatments (Table 1). No variations were found among the different textural classes of soil, the sand, silt and clay due to the application of herbicide oxyfluorfen 23.5%EC at 60 DAA as compared to before application of treatments (Table 1). The soil pH and electrical conductivity at 60 DAA was not differed with the testing herbicide oxyfluorfen 23.5%EC applied as mostly pre-matured flowering stage of the weeds. The data presented in Table 2 clearly showed that the organic carbon, total nitrogen, available phosphorus ( $P_2O_5$ ) and potash ( $K_2O$ ) contents also did not vary significantly.

## 5. Discussion

The decrease in the total bacterial population up to different dates was due to competitive influence and the toxic effect as well as different persistence periods of different chemical herbicides in different soil ecosystems. On the other hand, the increase was affected by the commensalic or proto-cooperative influence of various micro-organisms on total bacteria in the rhizosphere of potato. For all the cases of herbicidal treatments, total bacteria recovered from initial loss and exceeded than initial counts (Ghosh *et al.* 2012). Herbicidal the toxic effect or ammensalic or competitive influence of various micro-organisms caused the change of population of fungi in the rhizosphere soil of potato. From 10 DAA the population is again significantly increased in all the treatments because chemicals are degraded at that time and no toxic effect in the soil remained after the persistence period of the concerned herbicides. The change of population of actinomycetes in the rhizosphere soil of potato might be due to the competitive influence of various micro-organisms as well as toxic effect of the chemicals applied. Sapundjieva *et al.* (2008) reported similar findings. However in all the three cases (total bacteria, fungi and actinomycetes), the herbicide treatments did not vary much among themselves in all the three doses of the herbicide oxyfluorfen 23.5%EC, atrazine and pendimethalin at initial observation but after herbicide application they differ for a short period of time. Microorganisms are able to degrade herbicides and utilize them as a source of biogenic elements for their own physiological processes. However, before degradation, herbicides have toxic effects on microorganisms; reduce their abundance, activity and consequently, the diversity of their communities. The toxic effects of herbicides are normally most severe immediately after application, when their concentration in soil is highest. Later on, microorganisms take part in a degradation process, and herbicide concentration and its toxic effect gradually decline up to half-life. Then the degraded organic herbicide provides the substrate with carbon, which leads to an increase of the soil microflora. Similar findings were recorded by Sokolova and Gulidova, 2010. Based on the results, soil physico-chemical properties did not differ significantly under different treatments (Bera and Ghosh, 2013).

Considering soil microflora population (total bacteria, actinomycetes and fungi) and soil physico-chemical properties, Herbicidal treatments did not show any long run adverse effect on the field soil of the experimental field of potato and was safe in comparison to untreated control.

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## REFERENCES

- [1] Amakiri M A, 1982. Microbial degradation of soil applied herbicides. *Nig J Microl* 2: 17–21.
- [2] Ayansina A D V, Ogunshe A A O, Fagade O E, 2003. Environment impact assessment and microbiologist: An overview. In: Proceedings of 11th Annual National Conference of Environment and Behaviour Association of Nigeria: 26–27.
- [3] CIB, 1989. Manual for Testing Phytotoxicity of Pesticides on Agricultural Crops. Pesticides Association of India, New Delhi, 120 pp.
- [4] Ghosh R K, Jana PK, Nongmaithem D, Pal D, Bera S, Mallick S, Barman SK, Kole RK, 2012. Prospects of botanical herbicides in system of crop intensification in the Gangetic Inceptisols of India. Proceedings of 6th IWSC, Hangzhou, China, 17-22 June, 2012. pp-116-117.
- [5] Gomez KA, Gomez AA, 1984. Statistical Procedures for Agricultural Research, 2nd edn. Singapore: John Wiley & Sons.
- [6] Jackson ML, 1967. Soil chemical analysis. Prentice Hall of India Pvt. Ltd., New Delhi, pp. 183-347 and 387-08.
- [7] Kalia A, RP Gupta, 2004. Disruption of food web by pesticides. *Ind. J. Ecol.*, 31: 85-92.
- [8] Min H, YF Ye, ZY Chen, W X Wu, YF Du, 2002. Effects of butachlor on microbial enzyme activities in paddy soil. *J. Environ. Sci* 14: 413-417.
- [9] Mukherjee PK, Rahaman S, Maity SK, Sinha B, 2012. Weed management practices in potato (*Solanum tuberosum* L.). *J. Crop Weed* 8: 178-180.
- [10] Pramer D, Schmidt EL, 1965. Experimental soil microbiology. Burgess Publ. Co., Minneapolis.
- [11] Prasad K, Singh RS, 1995. Influence of weed-control measures on weed growth, nutrient uptake and tuber yield of potato (*Solanum tuberosum*). *Indian J. Agril. Sci* 6S: 46-8.
- [12] Reichardt W, A Dobermann, T George, 1998. Intensification of rice production systems: opportunities and limits. In: Sustainability of Rice in the Global Food System, N. G. Dowling, S. M. Greenfield and K. S. Fisher (eds.). Pacific Basin Study Centre and IRRI Publ. pp. 127-144.
- [13] Bera S, Ghosh RK, 2013. Soil Physico-Chemical Properties and Microflora as Influenced by Bispyribac Sodium 10% SC in Transplanted Kharif Rice. *Rice Sci* 20(4): 298-302.
- [14] Saeki M, K Toyota, 2004. Effect of bensulfuron-methyl (a sulfonylurea herbicide) on the soil bacterial community of a paddy soil microcosm. *Biol. Fertil. Soils* 40 : 110-118. Yadaraju, N. T. and J. S. Mishra, 2002. Herbicides-boon or bane? *Pestol* 26 : 43-46.
- [15] Sapundjieva K, Kalinova S, Kartalska Y, Naydenov M, 2008. Influence of pendimethalin herbicide upon soil microflora. *Pochvoznanie, Agrokhimiya I Ekologiya* 42(3): 49-55.

- [16] Singh VP, Bhan VM, 1999. Herbicide control of weed in potato (*Solanum tuberosum* L.) in vertisol. *Indian J. Weed Sc* 31: 214-17.
- [17] Sokolova TV, Gulidova VA, 2010. Change of the biological activity of soils under the effect of herbicides. *Zashchita I Karantin Rastenii* (8): 46-47.
- [18] Yadav R, Kumar VA, 2011. Bio-efficacy of herbicides against complex weed flora in potato (*Solanum tuberosum*) crop grown through mini plants. *Indian J. Agril. Sci* 81 : 386-8.