EVALUATION OF INDIGENOUS TECHNOLOGY FOR THE MANAGEMENT OF WHITEFLY, *Trialeurodes vaporariorum* L. (HOMOPTERA: ALEYRODIDAE) IN POTATO

Meena Thakur¹, VK Chandla¹ and Yogeeta Thakur¹

**ABSTRACT:** Plant-derived extracts and phytochemicals have long been a subject of research in an effort to develop alternatives to conventional insecticides. In the present study bioactivities of some plant extracts *viz.* *Jatropha curcas* L., *Nerium oleander* L., *Allium sativum* L. and *Urtica dioica* L. were tested at different intervals of spray and compared with two commercially available botanical insecticides, mycojaal and *B.t.* at 5 and 10% concentration and standard recommended insecticide, imidacloprid (0.03%) against *Trialeurodes vaporariorum* L. in potato. Among the test treatments, the highest population suppression of whiteflies was observed with cattle urine extract of *J. curcas* at 10 (90.6%) and 5% (83.4%) concentrations. At 10% test concentration mycojaal and methanolic extraction of *J. curcas* also proved as effective as imidacloprid that resulted in an average population reduction up to 90.22, 88.25 and 93.78% respectively over control. The different plant extracts and bio-pesticides were effective for longer duration at 10% (up to 4-7 days) as compared to 5% concentration, but they were effective up to 3-6 days only. All the treatments proved significantly better over control.

**KEYWORDS:** Indigenous technology, bio-pesticides, whitefly, *Trialeurodes vaporariorum*, cattle urine plant extracts, methanol extract

**INTRODUCTION**

Potato is grown in an area of about 1.83 million ha which accounts for approximately 1.3% of total cropping area of the country. With an annual production of 37.3 million t, India ranks second in world potato production (Anonymous, 2010). Irrespective of the good rank attained in production, the potato productivity is very low in the country. Political, economic, social and biological forces have altered agricultural practices in the last several decades which in turn invited a number of insect pests in potato crop, affecting production as well as quality of potato. Global losses up to 10-16 per cent have been estimated due to various insect pests and viruses in potato crop (Dhaliwal *et al.*, 2010). Among these, whitefly (*Trialeurodes vaporariorum* L.) has become the most notorious sucking pest. It desaps the leaves, causing stunted growth and depleted vigor of potato. It also secretes honeydews on which sooty-mould grows which interfere with the process of photosynthesis and may also lead to bacterial infection. To combat this menace thrust was given mainly on chemical insecticides. Application of phorate 10G @ 1.5 kg a.i./ha, quinalphos, 0.05%, and chlorpyriphos, 0.05% have been recommended (Chander and Singh, 1991; Kolase and Sawant, 2001). Indiscriminate use of pesticides resulted in the development of resistance and resurgence of target pests, residual hazards, lack of biodiversity and replacement of natural enemies. This threatening situation makes it imperative to study the efficacy of some safer, organic and eco-friendly methods against whitefly infestation in potato.

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The failure of modern tactics has forced the scientific community to go back to the traditional and indigenous products for tackling the pest problems. There are many indigenous practices followed by age old Indian farmers to obtain rich harvest from the land. Plant kingdom is a vast storehouse of bioactive chemicals, of which many of them can be exploited against insect pests as repellent, antifeedant, hormonal and other insecticidal activity. Bio-pesticides are an important group of naturally occurring, often slow-acting crop protectants that are usually safer to humans and the environment and are more acceptable than conventional pesticides, because of minimal residual effects (McCloskey et al., 1993). According to Kim et al. (2005) and Daoubi et al. (2005), bio-pesticides may provide alternatives to currently used synthetic pesticides for the control of plant pests. Neem seed kernel extract (NSKE) (5%) was found effective in managing the whitefly population in moong bean and neem oil (1%), neem leaf extract (40%) and NSKE (2%) against budfly in linseed (Gupta et al., 2000; Hussain et al., 2001). According to Ayurveda, the efficacy of plant extracts is increased many folds by extracting in cow urine in place of water. Gupta and Rawat (2004) has found NSKE (in cow urine) 3% as highly effective against budfly in linseed. Cow butter milk (CBM) (10-15 days old) used by the tribal for pest management in crops has been found effective against pod borer in chickpea (Gupta, 2007). In view of this, studies were carried out to find out the efficacy of cow urine and methanol extracts of plants against the whitefly in potato.

MATERIALS AND METHODS

The study was conducted at Central Potato Research Institute, Shimla, situated at 37° North latitude, 77° East longitude and at about 2200 m above mean sea level (amsl). The experiment was conducted in glasshouse conditions at an average temperature ranging from 28-30°C with 60-70% relative humidity during the month of May as the whiteflies are most active in Shimla hills during April-July.

Plant material and preparation of extracts

The plants namely ratna jyot (Jatropha curcas L.), kaner (Nerium oleander L), garlic (Allium sativum L) and stinging nettle (Urtica dioica L.) were used in the present studies. Fruits of J. curcas, leaves of N. oleander and U. dioica and bulbs of A. sativum were collected, chopped into small pieces, air dried under shade, pounded in mortar and the fine powders were subjected to extraction of the insecticidal principles in cow urine or methanol. In case of cattle urine plant extraction, the powdered plant parts were soaked in cattle urine in 1:10 ratio and incubated as such for proper fermentation up to about 15 days. Thereafter, the preparation was thoroughly mixed and filtered through Whatman filter paper no. 42 to remove particulate matter and stored in transparent bottles under refrigerator. The filtrate was considered as 100% and was further diluted with water to make 5 and 10% concentration for spray purpose. Methanol extract of the fruits of J. curcas was prepared via soxhlet apparatus.

The plant extracts were tested and compared with two commercial botanical formulations viz. mycojaal and Bacillus thuringiensis (B.t.) at the same test concentrations.

Insecticide

The insecticide imidacloprid (Confidor® 200SC, Bayer Crop Science, www.bayercropscience.com) was used as positive control treatment at the recommended application rate of 0.003%.

Bio-efficacy of different treatments

The number of whiteflies per plant was observed daily up to one week after the
application of treatments (replicated thrice) and duration of bio-efficacy was also worked out in different treatments.

Statistical analysis

Experimental data was subjected to analysis of variance (ANOVA) in Completely Randomized Design (CRD) using statistical software AGRIS.

RESULTS AND DISCUSSION

The results presented in tables 1 and 2 indicated that the population of whitefly was significantly reduced in treated potato plants both at 5 and 10% concentration as compared to untreated plants. Suppression of the whitefly population was higher at 10% concentration with a range of 31.12 to 66.09 flies per plant in different test treatments as compared to 44.56 to 98.40 at 5%. However both the test concentrations being superior over control (range 332 and 268.59). No phytotoxicity was observed while carrying out the experiments at 5 or 10% concentration of the test botanicals.

The insecticidal property of 10%, extracts of J. curcas (urine extract) (31.12 flies/plant), mycozaal (32.46 flies/plant) and J. curcas (methanol extract) (39.00 flies/plant) was as effective as imidacloprid (20.65 flies/plant) and resulted in an average population reduction up to 88.25-90.63% over control (Table 1). At 5% test concentration, J. curcas (urine extract) (44.56 flies/plant) and mycojaal (55.37 flies/plant) were proved best and resulted in an average of 44.56 and 55.37 flies per plant with a population reduction of 79.41-83.41% (Table 2). Both these treatments were as effective as imidacloprid up to 4 days of spray thereafter the persistence of botanicals started declining and gradual increase in whitefly population was noticed.

When the population reduction was compared after 7 days of application over the initial population in each treatment, again J. curcas proved best among the botanicals followed by mycozaal. Botanicals, known to have medicinal activity, were toxic to sweet

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Before spray</th>
<th>Av. no. of whiteflies per plant at different intervals of spray</th>
<th>Mean</th>
<th>Reduction in whitefly population over control (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1 day</td>
<td>2 day</td>
<td>3 day</td>
</tr>
<tr>
<td>J. curcas</td>
<td>120.50</td>
<td>0.00</td>
<td>0.00</td>
<td>2.75</td>
</tr>
<tr>
<td>J. curcas¹</td>
<td>135.75</td>
<td>0.50</td>
<td>0.75</td>
<td>7.50</td>
</tr>
<tr>
<td>N. oleander</td>
<td>126.00</td>
<td>0.25</td>
<td>2.00</td>
<td>16.50</td>
</tr>
<tr>
<td>A. sativum</td>
<td>112.75</td>
<td>0.75</td>
<td>4.50</td>
<td>16.25</td>
</tr>
<tr>
<td>U. dioica</td>
<td>125.50</td>
<td>0.00</td>
<td>0.00</td>
<td>8.00</td>
</tr>
<tr>
<td>B.t.</td>
<td>133.50</td>
<td>0.50</td>
<td>3.25</td>
<td>13.25</td>
</tr>
<tr>
<td>Mycojaal</td>
<td>141.75</td>
<td>1.00</td>
<td>0.25</td>
<td>6.00</td>
</tr>
<tr>
<td>Imidacloprid</td>
<td>117.50</td>
<td>0.00</td>
<td>0.00</td>
<td>2.25</td>
</tr>
<tr>
<td>Control</td>
<td>242.0</td>
<td>310.3</td>
<td>312.75</td>
<td>328.50</td>
</tr>
<tr>
<td>Mean</td>
<td>139.47</td>
<td>35.08</td>
<td>35.66</td>
<td>44.55</td>
</tr>
</tbody>
</table>

CD (0.05)

- Treatments (T) 20.38
- Intervals (I) 19.22
- T×I 57.67

¹methanol extract
potato whitefly, *Bemisia tabaci* (Ateyyat et al., 2009). The bio-efficacy of botanicals alone or in combination with cow urine has been reported by various workers against different insect pests in different crops (Mohapatra et al., 2009; Hegde and Nandihalli, 2009; Ahmed et al., 2010).

At both the test concentrations cow urine extract of *J. curcas* was more efficient as compared to methanol extract. Cattle urine has been used by the farmers for the management of pest and diseases as a traditional method (Banjo et al., 2003). Shukla et al., (2003) observed that fortification of cow urine with leaf extracts of various botanicals like neem, ipomoea, annonaa and jatropha resulted in increased insecticidal property of the former against *Trialeurodes ricini* (Misra), *Empoasca flavescens* F., *Scirtothrips dorsalis* Hood and *Dichocrocis punctiferalis* Guen. Similar results were observed by Patel et al. (2003) against sucking pests of cotton by neem leaf extract (10%) and *Annona* leaf extract (10%) along with cow urine (10%) proved better. Gupta and Pathak (2009) obtained better yield and significant population reduction of whitefly and pod borer in black gram with the admixture treatments, NSKE in cow urine 3% + dimethoate, 0.03% and neem oil, 0.5% + dimethoate, 0.03%. Biodynamic pesticides involving combination of cow urine with plant products *viz.* , NSKE, *Vitex negundo* proved better in reducing the shoot fly infestation (Mudigoudra and Balikai, 2009).

Farmers in Shimla hills (Rampuri, Fagu and Shoghi) were observed using the botanicals (*Lantana*, *Nerium*, *Urtica dioica*, neem etc.) in cattle urine against different insect pests and were getting satisfactory results up to 50-60% reduction in pest population.

**CONCLUSIONS**

The study reveals that plant extracts in cow urine and biopesticides are quite effective in reducing whitefly population in potato. Upon storage, the plant products may lose their efficacy due to some chemical or enzymatic reactions, microbial growth or other reasons.
In view of that, the indigenous knowledge based pest control methods would be better when accompanied by standardised methods of preparation, bio-safety and environmental guidelines for efficacy as well as quality of the crop and crop products.

**LITERATURE CITED**


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EVALUATION OF POTATO CULTIVARS AGAINST ARSENIC ACCUMULATION UNDER AN ARSENIC-CONTAMINATED ZONE OF EASTERN INDIA

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ABSTRACT: A field experiment was undertaken to evaluate the varietal tolerance and accumulation of arsenic by different potato cultivars at village Nonaghata in Nadia district of West Bengal during winter season of 2008-09 and 2009-10. Arsenic content in the irrigation water was 0.094 to 0.108 mg/l. Arsenic accumulation of different plant parts was in the following sequence: root > stem > leaf > tuber, irrespective of all cultivars. After harvesting, the least arsenic loading was observed in cultivar Kufri Jyoti (0.05 mg/kg) which also showed the highest productivity (32.32 t/ha). Cultivar Kufri Chandramukhi and locally grown variety Lal alu accumulated a lesser amount of arsenic and had also a higher yield compared with the other entries.

KEYWORDS: potato, cultivar, arsenic, yield, arsenic-contaminated zone

INTRODUCTION

Arsenic, the toxic metalloid has its long and nefarious history as a serious threat to the society because of its capability of causing terrible health hazards to human beings. Around 110 million inhabitants of ten countries in South and South-east Asia, viz., Bangladesh, Cambodia, China, India, Laos, Myanmar, Nepal, Pakistan, Taiwan and Vietnam suffer from this problem. Out of these countries in different parts of the world where groundwater arsenic contaminations and human suffering have been reported so far, the magnitude is considered to be the maximum in Bangladesh, followed by West Bengal, India (Sanyal, 2005). It has recently been recognized that As-contaminated groundwater used for irrigation may pose an equally serious health hazard to people eating food from irrigated crops (Williams et al., 2006), and that As accumulating in irrigated soils poses a serious threat to sustainable agriculture in affected areas (Alam et al., 2002).

Recent studies have shown that the contribution of food-chain towards arsenic pollution in human is many folds greater than that of the drinking water (Roychowdhury et al., 2003). The problem is predominant with the irrigated crops grown in affected areas where ground water is the major source irrigated through shallow pump-set. Uptake of arsenic by plants and translocation to its different parts vary within the crop, even among the cultivars of the same crop (Pilli et al., 2010). Potato is grown in nearly 150 countries and is the World’s single most important tuber crop with a vital role in the global food system and food security (Singh, 2010). It is essential to the livelihood of a large number of people, elsewhere it is less essential, but still very important for subsistence and income generation (Thiele et al., 2010). As potato output increased from 1.3 million t to over 34 million t over the last six decades (Scott and Suarez, 2011), India contributes 7.1% of total global potato production (Guenthner, 2010) in which, the state West Bengal contributes about 27.8% (Singh, 2010), and may be cultivated as a substitute of summer rice, as because least

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arsenic contamination. In this point of view our present investigation, which was mainly axed on the study of the varietal specificities of different potato cultivars towards arsenic uptake, wanted to emphasize the economic importance of such phenomenon.

MATERIALS AND METHODS

The experiment was conducted on the fields of farmers located in the village Nonaghata (Latitude 22°57’N, Longitude 88°33’E and Altitude 7.8m above sea level), in Haringhata Block, in the alluvial soils of Nadia district of West Bengal, India, during the winter season of 2008-09 and 2009-10. Many wells contaminated with arsenic have been used as irrigation source in this zone. The experimental site is under subtropical humid climatic conditions with a yearly average rainfall ranging between 1275 to 2560 mm and mean minimum and maximum temperature ranging from 10 to 41°C, respectively.

The soil of the trial was silty clay loam in texture, with pH 7.04, EC 0.20/dsm, organic carbon 0.51%, available nitrogen 191 kg/ha, available phosphorus 36 kg/ha and available potassium 149 kg/ha (Baruah and Barthakur, 1997). Arsenic content in the irrigation water and soil of the experimental site were 0.094 mg/l and 8.28 mg/kg in the 1st year and 0.108 mg/l and 8.47 mg/kg in the 2nd year of the experiment. The experiment was laid out in a Randomized Block Design (RBD), replicated thrice with eight potato cultivars viz., Kufri Jyoti, Kufri Naveen, Kufri Jawahar, Kufri Chandramukhi, Kufri Badshah, Kufri Pukhraj, Kufri Bahar, Super Six and a locally grown variety Lal alu. The experiment was conducted for two consecutive years in the same field without disturbing the experimental layout where Aman rice was the previous crop.

Planting was done in the mid of November, with 150 kg N, 100 kg P₂O₅ and 100 kg K₂O/ha, half N and full P₂O₅ and K₂O were applied before planting and the remaining N at the time of earthing-up. Irrigation was provided immediately after planting, subsequent irrigations were applied at ten days intervals and it was stopped about 15 days prior to harvesting. Water extracted from arsenic-contaminated ground water through shallow pump-set was used for irrigation.

Plant samples were collected three times, vegetative stage (40 days after planting), maturity (80 days after planting) and after harvest (100 days after planting). First, the plant samples were washed with pure water, to remove the soil particles attached to the plant, and then with distilled water. Roots, stems, leaves and tubers were collected separately and cut into small pieces. Then the samples were air dried and grinded and kept in the packet.

Plant samples were weighted to 1 g and digested with tri-acid mixture (HNO₃: H₂SO₄: HClO₄: 10:1:4, v/v) until a clear solution was obtained. Then they were filtered by using Whatman No. 42 filter paper. Ten ml of the filtrate was taken and poured in 50 ml volumetric flask, to which 5 ml of concentrated HCl and 1 ml of mixed reagent [5% KI (w/v) + 5% Ascorbic acid (w/v)] were added and they were kept for 45 minutes to ensure a complete reaction and the volume was made up to 50 ml. The total arsenic content in the solution was determined by using atomic absorption spectrophotometer (AAS), Perkin Elmer Analyst 200 coupled with Flow Injection Analysis System (FIAS 400) where the carrier solution was 10% v/v HCl, following Olsen method as described by McLaren et al. (1998). A set of standard solutions of 2.5, 5.0, 10.0, and 20.0 mg/l were used for calibration. Analysis of variance method (Gomez and Gomez, 1976) was used for statistical analysis.
RESULTS AND DISCUSSION

Accumulation pattern of arsenic

The maximum accumulation of arsenic was observed in the roots (55%) as compared with the other plant parts (Fig. 1). The roots contained a higher arsenic content than stems > leaves > tubers at different plant growth stages. Stem and leaves recorded approximately 2.5 times lesser concentration of arsenic as compared with the arsenic accumulated in the roots. Stems (23%) accumulated higher concentration of arsenic than leaves (19%). Finally, the potato tubers (3%) accumulated very low concentration of this toxic metalloid as compared to all other plant parts. Comparison of arsenic accumulation of different plant parts of potato clearly showed that translocation of arsenic in edible part is relatively lower than the any other plant parts. In general, the distribution of arsenic in plant parts is found to be in the order: root > shoot (Abedin et al., 2002; Sanyal, 2005).

Arsenic accumulation at vegetative stage

At the vegetative stage of potato (40 days after planting), accumulation of arsenic by different plant parts varied significantly across the cultivars tested (Table 1). Arsenic accumulation of different plant parts was sequentially: root > stem > leaf > tuber, irrespective of all the cultivars. The maximum arsenic accumulation in roots was observed

<table>
<thead>
<tr>
<th>Cultivar</th>
<th>Vegetative stage</th>
<th>Maturity</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Root</td>
<td>Stem</td>
</tr>
<tr>
<td>Kufri Jyoti</td>
<td>1.25</td>
<td>0.86</td>
</tr>
<tr>
<td>Kufri Naveen</td>
<td>0.91</td>
<td>0.33</td>
</tr>
<tr>
<td>Kufri Jawahar</td>
<td>1.10</td>
<td>0.59</td>
</tr>
<tr>
<td>Kufri Chandramukhi</td>
<td>1.88</td>
<td>1.06</td>
</tr>
<tr>
<td>Kufri Badshah</td>
<td>2.06</td>
<td>1.05</td>
</tr>
<tr>
<td>Kufri Pukhraj</td>
<td>1.57</td>
<td>1.01</td>
</tr>
<tr>
<td>Kufri Bahar</td>
<td>2.22</td>
<td>1.30</td>
</tr>
<tr>
<td>Super six</td>
<td>2.13</td>
<td>0.77</td>
</tr>
<tr>
<td>Lal alu (local)</td>
<td>1.37</td>
<td>0.36</td>
</tr>
<tr>
<td>SEM (±)</td>
<td>0.11</td>
<td>0.07</td>
</tr>
<tr>
<td>CD (0.05)</td>
<td>0.31</td>
<td>0.23</td>
</tr>
</tbody>
</table>

Fig. 1 Arsenic accumulation pattern of potato (average value of all cultivars).
in cultivar Kufri Bahar (2.22 mg/kg) and it was statistically at par with the cultivar Super Six (2.13 mg/kg) and Kufri Badshah (2.06 mg/kg), whereas, least arsenic loading by roots was observed under the cultivar Kufri Naveen (0.91 mg/kg) followed by Kufri Jawahar (1.10 mg/kg). In the case of stems, among all tested cultivars, Kufri Bahar (1.30 mg/kg) accumulates significantly the highest amount of arsenic whereas Kufri Naveen (0.33 mg/kg) and local cultivar Lal alu (0.36 mg/kg) showed the significantly least arsenic accumulation. The highest arsenic accumulation in leaves was found in cultivar Kufri Pukhraj (0.98 mg/kg) which was not significantly different from cultivar Kufri Bahar (0.92 mg/kg), whereas, locally grown cultivar Lal alu (0.10 mg/kg) and cultivar Kufri Chandramukhi (0.12 mg/kg) recorded the least arsenic in their leaves. Finally, tubers of cultivar Kufri Badshah (0.16 mg/kg) loaded the significantly highest amount of arsenic, followed by cultivars Super Six (0.14 mg/kg) and Kufri Bahar (0.14 mg/kg), respectively. The least amount of arsenic accumulation was noticed in the tubers of cultivar Kufri Jyoti (0.01 mg/kg), but there were no significant differences with the cultivar Kufri Jawahar (0.02 mg/kg).

**Arsenic accumulation at maturity**

At maturity (80 days after planting), the degree of arsenic loading by different plant parts was also in the same sequence as it was shown previously (Table 1). The maximum arsenic loading by roots and stems was recorded in cultivar Super Six (2.96 and 0.86 mg/kg, respectively) and it was closely followed by cultivars Kufri Bahar and Kufri Pukhraj. Among the all cultivars, the least amount of arsenic in roots and stems (1.29 and 0.60 mg/kg, respectively) was found in cultivar Kufri Jyoti. In the case of potato leaves, cultivar Kufri Bahar (1.11 mg/kg) accumulates the maximum amount of arsenic, which had no significant difference with cultivar Super Six (1.06 mg/kg), whereas, locally grown Lal alu (0.45 mg/kg) recorded significantly least amount of arsenic in the leaves. Finally, tubers of cultivar Super Six (0.23 mg/kg) accumulated the highest amount of arsenic, followed by cultivar Kufri Badshah (0.21 mg/kg), whereas cultivar Kufri Jawahar (0.02 mg/kg) loaded the least amount of arsenic and it was not statistically different from cultivars Kufri Jyoti (0.03 mg/kg) and Kufri Naveen (0.05 mg/kg), respectively.

**Arsenic accumulation after harvest**

After harvest (100 days after planting), accumulation of arsenic in potato tubers also differed significantly among cultivars (Table 2). The least amount of arsenic load in potato tubers was observed in cultivars Kufri Jyoti (0.05 mg/kg), Kufri Naveen (0.06 mg/kg), Kufri Jawahar (0.10 mg/kg) and local Lal alu (0.12 mg/kg), whereas, the maximum arsenic accumulation was recorded in cultivars Super Six (0.34 mg/kg), Kufri Badshah (0.30 mg/kg) and Kufri Bahar (0.28 mg/kg).

**Potato Production**

Tuber yield was recorded at harvesting differed significantly among cultivars (Table 2). The maximum tuber yield was observed in cultivar Kufri Jyoti (32.32 t/ha), followed by cultivar Kufri Chandramukhi (29.56 t/ha) and local Lal alu (28.46 t/ha), whereas cultivars Kufri Bahar (24.21 t/ha), Kufri Naveen (25.36 t/ha), Super Six (25.76 t/ha) Kufri Jawahar (25.98 t/ha) and Kufri Badshah (26.45 t/ha) produced the lowest yield among the nine cultivars tested.

**Comparison of arsenic accumulated in tubers**

Comparison of arsenic accumulated in the tubers at three different stages of the potato plant is shown in fig. 2. The accumulation of arsenic increases during the plant growth,
irrespective of all cultivars tested. In the case of cultivars Kufri Jyoti, Kufri Jawahar, Kufri Badshah, Kufri Pukhraj, Kufri Bahar and Super Six, this was more evident than in other tested entries. As arsenic accumulation is concern, winter cereals (summer rice and wheat) cultivated in the same zone contain arsenic in a higher magnitude, summer rice ranges 0.04-0.91 mg/kg (Williams et al., 2006); 0.06-1.84 mg/kg (Meharg and Rahman, 2003); 0.08-0.55 mg/kg (Roychowdhury et al., 2003) and in wheat 0.36 mg/kg (Roychowdhury et al., 2002); 0.87 mg/kg (Samal, 2005). In comparison to that accumulation of arsenic in potato tuber (ranges 0.05-0.34 mg/kg, mean 0.17 mg/kg) from the present investigation reveals, this tuber crop contains lesser amount of arsenic in its consumable plant part. The

Table 2. Arsenic accumulation (mg/kg) by tubers and yield (t/ha) of different cultivars of potato at harvest (mean data of 2 years).

<table>
<thead>
<tr>
<th>Cultivar</th>
<th>Arsenic uptake by tuber</th>
<th>Yield (t/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kufri Jyoti</td>
<td>0.05</td>
<td>32.32</td>
</tr>
<tr>
<td>Kufri Naveen</td>
<td>0.06</td>
<td>25.36</td>
</tr>
<tr>
<td>Kufri Jawahar</td>
<td>0.10</td>
<td>25.98</td>
</tr>
<tr>
<td>Kufri Chandramukhi</td>
<td>0.13</td>
<td>29.56</td>
</tr>
<tr>
<td>Kufri Badshah</td>
<td>0.30</td>
<td>26.45</td>
</tr>
<tr>
<td>Kufri Pukhraj</td>
<td>0.19</td>
<td>28.32</td>
</tr>
<tr>
<td>Kufri Bahar</td>
<td>0.28</td>
<td>24.21</td>
</tr>
<tr>
<td>Super Six</td>
<td>0.34</td>
<td>25.76</td>
</tr>
<tr>
<td>Lal alu (local)</td>
<td>0.12</td>
<td>28.46</td>
</tr>
<tr>
<td>SEM (±)</td>
<td>0.02</td>
<td>1.24</td>
</tr>
<tr>
<td>CD (0.05)</td>
<td>0.07</td>
<td>3.72</td>
</tr>
</tbody>
</table>
arsenic accumulation of different irrigated crops followed an order in summer rice > wheat > potato.

The experiment clearly revealed that the tested entries differed in terms of arsenic accumulated in their different parts as well as the trend of arsenic accumulation. It is possibly due to varietal diversity. Arsenic accumulation in potato tubers increases with plant growth and this may be due to increased arsenic contaminated groundwater irrigation with plant growth. Cultivar Kufri Jyoti accumulated the least amount of arsenic in its tubers with highest yielding capacity, whereas Kufri Chandramukhi and locally grown variety Lal alu recorded the most moderate amount of arsenic in their tubers and also produced higher yield. On the other hand, cultivars Super Six and Kufri Bahar showed with highest contamination of arsenic with lower yielding capacity, again, some cultivars like Kufri Naveen and Kufri Jawahar accumulated the lowest amount of this toxic metalloid and also produced relatively lower yield of potato. So, yield of potato may not be affected by the level of arsenic concentration in the environment but the quality of tubers is highly affected. Preference should be given to those cultivars having the highest production ability with the least accumulation of arsenic in their edible parts.

CONCLUSIONS

In Eastern India, particularly West Bengal, where potato is a common food for all the people, it is necessary to search for appropriate agricultural management practices to minimize the arsenic content in the tubers. Though the arsenic accumulated in potato tubers is relatively lower than in the other crops, the large consumption of it can cause a high risk to the health of the population in these areas. The arsenic accumulation pattern differs among the tested potato entries. Kufri Jyoti, Kufri Chandramukhi and local Lal alu accumulated lesser amount of arsenic in their edible parts than the other entries did and had also a higher yielding capacity. Therefore, appropriate selection of potato cultivars in this area heavily contaminated by arsenic is very important to minimize the toxicity entering into the food chain.

LITERATURE CITED


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