I J T A
© Serials Publications
National Academy of Agricultural Science (NAAS) Rating : 3.03

Efficacy of Certain Plant Products on the Incidence of Major Insect Pests of Potato (*Solanum tuberosum* L.)

Eloni Felicity* and I. T. Asangla Jamir*

ABSTRACT: *A field experiment was conducted in the Experimental Research Farm of School of Agricultural Sciences and Rural Development, Nagaland University, Medziphema Campus during November 2011 to February 2012 to study the pest management of potato with certain plant extracts. The study was conducted in Randomized Block Design with six treatments having four replications* viz. *Eucalyptus ash 5% @ 20ml/lit, Neem oil 1% @ 5ml/lit,* Zanthoxyllum oxyphyllum *seed extract 2% @ 20 ml/lit,* Costus specious *2% @ 20 ml/lit, Monocrotophos 36 SL 0.07% @ 2ml/lit and untreated control. The best result was indicated by Neem oil 1% @ 5ml/lit followed by* Costus specious *2% @ 20ml/lit,* Zanthoxyllum oxyphyllum *seed extract 5% @ 20ml/lit and Eucalyptus ash 5% @ 20ml/lit. Monocrotophos 36 SL 0.07% @ 2ml/lit found to be most effective in all the time of treatment period. Among plant products application of Eucalyptus ash @ 5% was found to obtain highest net return and Benefit Cost ratio.*

Keywords: *Potato, Pest complex, Efficacy, Plant products*

INTRODUCTION

Potato is known as the king of vegetables and is one of the world's most important tuber crops. Potato occupies fourth position after wheat, maize and rice. Potatoes are one of the richest sources of minerals, vitamins (A, B, C, P) water starch and potato tuber was introduced accidentally into India from Italy in 1906. About 80 species of potato pest have been reported from India (Saxena and Mishra, 1983) out of which a dozen of then are responsible for economic losses (Kishore and Mishra, 2001). In India total production of potatoes is 41328.32 MT (Source-indiastat.com 2011-2012). Uttar Pradesh has the largest area and production of Potato, followed by Bihar, West Bengal and Assam (Saini 1996). The per capita of Potato per yea in Meghalaya and Nagaland states are 78.7 kg and 24.1 kg respectively much higher to the national per capita of 18 kg (Singh *et al*., 2003). In all the NEH states, Tripura has the highest yield about 19.68 tons/ha in the area of 540 ha (Gupta *et al*., 2004). In Nagaland the total production of Potato is 20.15 MT (Source: indiastat.com 2011-2012). At present, Potato pests are managed by application of pesticides which are very hazardous. Farmers indiscriminately apply chemicals for protective purposes against pest. Apart from synthetic pesticides botanicals are found to be very effective and possess an array of insecticidal properties to use against insect and insect and mite pests (Prakash and Rao, 1986). Plant extracts like *Litsea citrate*, *Costus speciosus* seed extract stem extract *Chenopodium ambrosioides* seed extract found to be very effective against Rice pests in the field. (Albert Shitiri *et al*., 2014). Plant products were found to be very effective against Angoumois grain moth; *Sitotruga cerealella* Olivier (Asangla I.T. Jamir *et al*., 2013).Thus keeping these views and considering the importance of these problems, the present research programme was carried out.

MATERIALS AND METHODS

An experiment was carried out in the Entomological farm SASRD Medziphema campus, it is situated at 25° 4'5, 45"N latitude and 93° 5'5 04' E longitude elevated at 310 m above sea level. Rainfall ranges from 2000-2500 mm. the mean temperature ranges from 25° to 35 °C during summer and upto 8 °C in winter. The cultivar Kufri Jyoti was used for carrying out the experiment. Three locally and cheaply available plant

* Department of Entomology, School of Agricultural Sciences and Rural Development Nagaland University: Medziphema-797106, Nagaland, *E-mail: itasanglajamir@yahoo.in*

products *viz.* Costus (*Costus speciosus* J. Koenig) bark extract, Zanthoxyllum (*Zanthoxyllum oxyphyllum* Edgw) seed coat and Eucalyptus bark were collected from in and around Medziphema and other parts of Nagaland for use as treatments for present investigation. Zanthoxyllum seed coat was shade dried for about a week and grinded into powdered form by maxi grinder. The powder thus obtained was extracted with the help of Soxhlet apparatus. Eucalyptus bark was burnned and the ash so obtained was soaked in water for overnight and was filtered with the help of filter paper. *Costus speciosus* stem was crashed and liquid was extracted with the help of metallic motar.

Bark of Euclayptus was burned and about 150gm ash was soaked in 3 litres of water, filtered and extracted. The population count of pest's incidence was carried out on aphids, white-flies, and leaf-hoppers in a separate control plot. Five plants were randomly selected and tagged and the population count was carried out at weekly intervals throughout the cropping period starting from 30 days after sowing.

A number of insect pests were observed during the cropping period showing different feeding behavior. Different sampling methods were employed for estimating their population. Details of the different sampling methods are given below. Observation on aphids and white flies' population was recorded by counting the number of nymphs as well as adults from three leaves (top, middle and bottom) per plant from five randomly tagged plants per plot. The data thus obtained were computed and subjected to suitable analysis. Sweep method by using a hand net was adopted and population of leafhopper per 5 sweeps per plot was taken into account.

Observations were made from five randomly tagged plants. The plants were examined for the presence of beetles or caterpillars and symptoms of infestation such as withering of plants, yellowing and skeletonization of leaves, holes in the shoots and leaves with excreta.

Observations on the efficacy of certain plant products employed for carrying out the experiment were recorded as pre-treatment and post-treatment count. The population of aphids, white fly, beetles or caterpillars and leaf hoppers were recorded one day before application of treatments and at three, seven and fourteen days after treatment as per the above sampling method.

The population of natural enemies of potato pests were observed and recorded by visual observation on the pest infested plant. Those generalist predators that were found hovering within the potato field were also observed and recorded.

Gross return was estimated considering the monetary value of the economic produce of different treatments based on the prevailing market prices per ha of the different produce. Net return for each treatment was estimated by subtracting the total cost of cultivation from the gross return treatment wise.

Net return = Gross return – Cost of cultivation

Benefit Cost ratio was calculated by the following formula:

$$Benefit\ cost\ ratio = \frac{Gross\ return}{Cost\ of\ cultivation}$$

The data collected for various observations were subjected to the square root transformation before analysing statistically. The formula used for transformation is.

$$\sqrt{X + 0.5}$$

Where 'X' is the number of individual pest under observations.

The transformed values were subjected analysis of variance (ANOVA) by Randomized Block Design (RBD). 'F' test was used to determine the significance and non-significance of the variance due to different treatments. The ANOVA table are annexed under the appendices.

RESULTS

Fourteen insect pests were recorded during the course of investigation exhibiting different feeding behavior in all the crop stages. Aphid *A. gossypii*, leaf hopper *A. biguttula biguttula*, flea beetle *Podagrica spp*, whitefly *B. tabaci* and Green stink bug *N.viridula* were observed from vegetative stage till harvest. Green stink bug *N. viridula*, Grasshopper *O.japonica* were observed throughout the cropping period. Hadda beetle *E. vigintioctopunctata* and cutworm *A. ipsilon* was observed 62-92 days after sowing during vegetative stage. Black ant *M. brunnea* and Red ant *D. orientalis* were observed only for a short duration duration during the vegetative stage. Out of fourteen insect species aphid, leaf hopper and white fly were observed throughout the cropping period. They were considered as the major pests since their activity persisted in the field till the last stage of the cropping period causing severe damage to the crop.

As presented in table 1. the incidence of aphid, *A. gossypii*was highest during 11th week with a mean number of 6.45 aphids per leaf while lowest was

Table 1
Incidence of major insect pests of potato during December, 2011 to February, 2012

Standard weeks	*Temperature (°C)*		*Relative Humidity (%)*		*Rainfall (mm)*	*Major pests * Number per leaf*		
	Max	*Min*	*Max*	*Min*		*Aphis gossypii*	*Bemisia tabaci*	*Amrasca biguttulla biguttulla*
7th Dec	25.70	14.36	82.00	35.27	0.00	0.25	0.00	0.25
14th Dec	23.99	10.64	81.14	20.47	0.00	2.00	0.00	0.50
21th Dec	25.70	14.36	82.00	35.29	0.00	2.25	0.00	1.25
28th Dec	23.99	10.64	81.14	20.47	0.00	3.50	0.00	0.75
4th Jan	23.21	7.16	76.00	7.43	0.00	4.00	1.00	1.50
11th Jan	24.44	9.57	74.71	6.14	0.00	4.00	2.50	1.50
18th Jan	21.64	11.47	77.29	27.00	1.49	6.45	3.00	3.75
25th Jan	20.44	11.84	80.00	32.29	1.56	4.16	1.38	2.00
1st Feb	20.41	11.27	70.14	48.29	0.23	3.89	0.63	0.88
8th Feb	20.73	9.36	75.86	32.71	0.34	2.50	1.88	0.63
15th Feb	23.53	7.90	72.57	9.43	0.00	1.73	1.88	0.50

*Mean value of five plants

recorded on 5th week with 0.25 aphids per leaf. Correlation studies between aphid population and weather parameters had shown a negative non significant correlation with maximum and minimum relative humidity. Minimum relative humidity had showed a negative significant correlation. The incidence of leaf hopper, *A. biguttula biguttula* population revealed that the highest incidence was recorded during 11th week with 3.75 leaf hopper per leaf while the lowest mean number was recorded on 5thweek with 0.25 leaf hopper per leaf . Leaf hopper population had shown a negative non significant correlation with maximum and minimum relative humidity.The incidence of white fly, *B. tabaci* population started only on 9th week. The highest incidence was recorded on 11th week with 3.00 white fly per leaf while minimum population was recorded on 13th week with 0.63 white fly per leaf. White fly population had shown a negative non significant correlation with maximum and minimum relative humidity. Maximum relative humidity had shown a negative significant correlation.

As presented in table (2) Efficacy of different treatments against the population of aphids revealed that neem oil 1% was superior over the rest of the treatments. The next best treatment was *costus speciosus* 2% followed by *Zanthoxyllum oxyphyllum* 2% which was at par with each other. Eucalyptus ash 5%

Table 2
Efficacy of certain plant products on the population of Aphids, *Aphis gossypii*

Treatments	*Number of aphid per leaf*							
	1st SprayPercent (%) reduction				*2nd SprayPercent (%) reduction*			
	1 DBS	*3 DAS*	*7 DAS*	*14 DAS*	*1 DBS*	*3 DAS*	*7 DAS*	*14 DAS*
T_{0-} Control	3.00	0.00^{c} (0.71)	4.79^{c} (8.92)	0.00^{b} (0.71)	2.00	0.00^{c} (0.71)	12.50^{d} (11.25)	0.00^{b} (0.71)
T_1- Eucalyptus ash	2.03	39.58^{bc} (38.82)	50.00^{b} (45.00)	85.42^{a} (73.68)	1.33	57.08^{b} (50.59)	70.50^{bc} (78.75)	60.50^{a} (90.00)
T_2- Neem oil	3.78	50.00^{ab} (45.00)	85.71^{ab} (73.84)	96.43^{a} (84.45)	2.03	88.70^{ab} (90.00)	100.00^{a} (90.00)	100.00^{a} (58.68)
T_3- *Zanthoxyllum oxyphyllum*	3.25	15.63^{bc} (13.06)	62.50^{ab} (52.50)	96.88^{a} (84.82)	1.05	60.50^{b} (90.00)	58.50^{c} (90.00)	75.00^{a} (67.50)
T_4- *Costus speciosus*	6.25	39.91^{b} (35.14)	82.86^{ab} (68.64)	91.43^{a} (77.81)	1.78	79.17^{ab} (69.93)	80.00^{b} (90.00)	87.50^{a} (78.75)
T_5- Monocrotophos	5.75	86.67^{a} (71.31)	95.00^{a} (83.36)	95.00^{a} (83.36)	1.08	100.00^{a} (90.00)	100.00^{a} (90.00)	100.00^{a} (90.00)
SEm±	1.25	12.51	11.36	6.78	0.72	9.65	6.27	12.84
CD (P = 0.05)	NS	44.05	40.01	23.88	NS	33.98	22.1	45.22

Note: DBS- Day before spraying. DAS- Days after spraying.
Figures in the table are mean values and that in parenthesis are angular transformed values.
Same small letter (s) in a column after mean values indicates non-significant different from each other at 5% level of significance

has shown a significant effect only on third and seventh days after spraying on second treatment. Results on the effect of different treatments in the population reduction of white fly as presented in table (3) had shown that neem oil was the most effective treatment. 100% reduction equally with Monocrotophos, followed by Costus speciousus 100% reduction after spraying on 14 days on both 1st and 2nd spray which has similar effectiveness with Monocrotophos, followed by Zanthoxyllum oxyphyllum. Eucalyptus ash 5% was at par at three and seven days after spraying on second treatment. However the effect of treatments over the untreated control differed significantly on all the days of observation at both spray schedules. The findings of the present study presented in table (4) had revealed that the effect of treatments against leaf hopper, *A. biguttula biguttula* differed on different days neem oil, *costus speciosus* and *Zanthoxyllum oxyphyllum* were superior at three and seven days, while eucalyptus ash was most effective on fourteen days after second spraying.

Table 3
Efficacy of certain plant products on the population white fly, *Bemisia tabaci*

Treatments	*Number of white fly per leaf*							
	1st SprayPercent (%) reduction				*2nd SprayPercent (%) reduction*			
	1 DBS	3 DAS	7 DAS	14 DAS	1 DBS	3 DAS	7 DAS	14 DAS
T_{0-} Control	3.00	18.75 (15.00)	8.33^{b} (8.82)	0.00^{b} (0.00)	2.63	4.17^{b} (6.02)	25.00^{b} (22.00)	25.00^{c} (22.00)
T_1- Eucalyptus ash	2.52	21.28 (23.80)	60.04^{a} (50.92)	65.00^{a} (90.00)	2.88	75.00^{a} (67.50)	75.00^{a} (67.50)	68.27^{b} (63.43)
T_2- Neem oil	2.26	30.77 (29.68)	87.50^{a} (78.75)	85.00^{a} (67.50)	1.83	100.00^{a} (90.00)	100.00^{a} (90.00)	100.00^{a} (90.00)
T_3- *Zanthoxyllum oxyphyllum*	2.71	14.10 (15.99)	55.56^{a} (48.23)	75.96^{a} (70.33)	2.45	80.83^{a} (71.71)	83.33^{a} (76.32)	100.00^{a} (90.00)
T_4- *Costus speciosus*	2.50	12.50 (11.25)	58.33^{a} (49.87)	100.00^{a} (90.00)	2.10	75.00^{a} (67.50)	97.50^{a} (85.39)	100.00^{a} (90.00)
T_5- Monocrotophos	2.34	40.56 (25.73)	65.00^{a} (4.50)	100.00^{a} (62.63)	2.40	100.00^{a} (90.00)	100.00^{a} (90.00)	100.00^{a} (90.00)
SEm±	0.35	13.84	14.82	15.75	0.44	9.91	9.19	9.19
CD (P = 0.05)	NS	NS	NS	NS	NS	32.35	32.35	32.35

Note: DBS- Day before spraying. DAS- Days after spraying.
Figures in the table are mean values and that in parenthesis are angular transformed values.
Same small letter (s) in a column after mean values indicates non-significant different from each other at 5% level of significance

Table 4
Efficacy of certain plant products on the population of leaf hopper, *Amrasca biguttulla biguttulla*

Treatments	*Number of leaf hopper per leaf*							
	1st SprayPercent (%) reduction				*2nd SprayPercent (%) reduction*			
	1 DBS	3 DAS	7 DAS	14 DAS	1 DBS	3 DAS	7 DAS	14 DAS
T_{0-} Control	3.00	0.00^{c} (0.71)	4.79^{c} (8.92)	4.17^{b} (6.02)	2.00	0.00^{c} (0.71)	12.50^{b} (11.25)	0.00^{b} (0.71)
T_1- Eucalyptus ash	2.03	39.58^{bc} (38.82)	50.00^{b} (45.00)	85.42^{a} (73.68)	1.33	57.08^{b} (50.59)	87.50^{a} (78.75)	100.00^{a} (90.00)
T_2- Neem oil	3.78	50.00^{ab} (45.00)	85.71^{ab} (73.84)	96.43^{a} (84.45)	2.03	100.00^{a} (90.00)	100.00^{a} (90.00)	66.67^{a} (58.68)
T_3- *Zanthoxyllum oxyphyllum*	3.25	15.63^{bc} (13.06)	62.50^{ab} (52.50)	96.88^{a} (84.82)	1.05	100.00^{a} (90.00)	100.00^{a} (90.00)	75.00^{a} (67.50)
T_4- *Costus speciosus*	6.25	39.91^{bc} (35.14)	82.86^{ab} (68.64)	91.43^{a} (77.81)	1.78	79.17^{ab} (69.93)	100.00^{a} (90.00)	87.50^{a} (78.75)
T_5- Monocrotophos	5.75	86.67^{a} (71.31)	95.00^{a} (83.36)	98.00^{a} (83.36)	1.08	100.00^{a} (90.00)	100.00^{a} (90.00)	100.00^{a} (90.00)
SEm±	1.25	12.51	11.36	6.78	0.72	9.65	6.27	12.84
CD (P = 0.05)	NS	44.05	40.01	23.88	NS	33.98	22.1	45.22

Note: DBS- Day before spraying. DAS- Days after spraying.
Figures in the table are mean values and that in parenthesis are angular transformed values.
Same small letter (s) in a column after mean values indicates non-significant different from each other at 5% level of significance

Table 5
Correlation coefficient (r) of potato pests population with weather parameters

Weather parameters	*Aphis gossypii*	*A. biguttula biguttula*	*Bemisia tabaci*
Maximum Temperature (°C)	-0.716^{NS}	-0.328 ^{NS}	-0.281 ^{NS}
Minimum Temperature (°C)	-0.08 ^{NS}	-0.534 ^{NS}	-0.544 ^{NS}
Maximum Relative humidity (%)	-0.749 ^{NS}	-0.761 ^{NS}	-0.93*
Minimum Relative humidity (%)	-0.84*	-0.616 ^{NS}	-0.77 ^{NS}

Note: * = Significant at 5% level of significance.
NS = Non-significant at 5% level of significance.

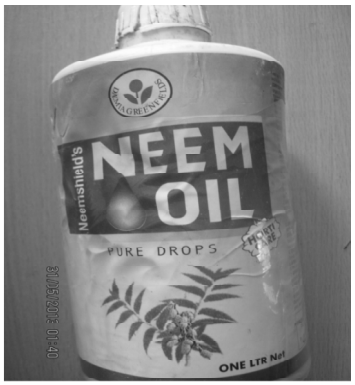
Plate 1: General view of the experimental plot

A. Costus plant **B. Costus flower**

Plate 2: Costus and Costus flower

A: Bark of Eucalyptus tree

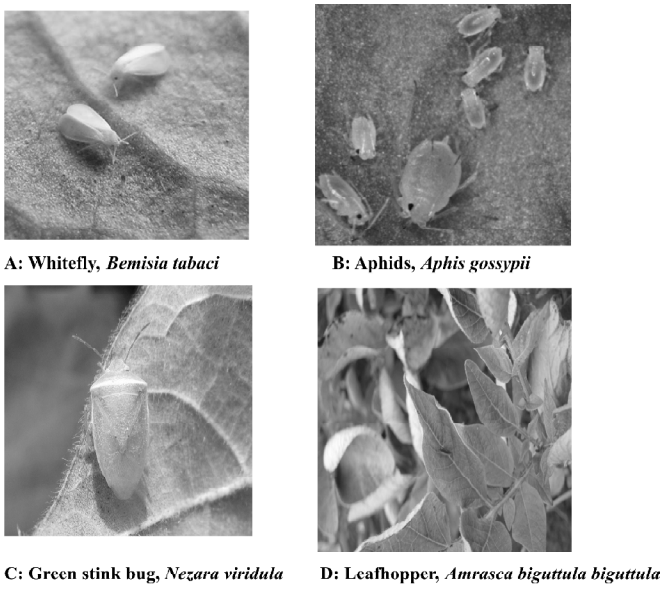
B: Eucalyptus tree



D:Neem oil

C: *Zanthoxyllum oxyphyllum* seed coat

Plate 3: Bark of Eucalyptus tree, Eucalyptus tree, Neem oil and *Zanthoxyllum oxyphyllum*



A: Whitefly, *Bemisia tabaci* B: Aphids, *Aphis gossypii*

C: Green stink bug, *Nezara viridula* D: Leafhopper, *Amrasca biguttula biguttula*

Plate 4: Whitefly, Aphids, Green stink bug and Leafhopper

DISCUSSION

Fourteen insect pests recorded during the period of investigation were found with different feeding habits from vegetative state till harvesting stage major pests aphid, *Aphis gossypi*, leaf hopper *Ambrasca bigutulla*, and white fly *Bemisia tabaci*. The present findings are in conformity with the findings with the findings of Bhushan and sharnappa (2009) and Zaki and Masoodi (1990) who reported the fourteen insect pests attacked potato crop at different crop stages. Gajendra (1982) also indicated that aphids, leaf hoppers, whitefly were the major pest of potato found throughout the cropping period, similar finding was reported by Singh (1990), who recorded the major damage to the tubers caused by aphids, whiteflies, leafhoppers, termites and epilachna beetle. Similar findings were reported by Gulab *et al.* (1998) and Mogahed (2003). This is in conformity with the present findings.

The incidence of aphid was observed from 7th December with a mean aphid population of 0.25 aphids per leaf. The peak population was observed during 2nd week of January with a mean population of 6.45 aphid per leaf. The present findings are conformity with Verma and Parihar (1996) who reported that the activity of aphid on potato became more pronounced from 2nd week of January. Aphid population showed a negative non-significant correlation with abiotic factors like maximum and minimum temperature and relative humidity. The peak incidence of leaf hopper was (3.75)observed per leaf on 18th January. This is in conformity with Parihar *et al*. (1994) who observed that the incidence of leaf hopper population in potato reached its peak during 3rd week of January. Leaf hopper population indicated a negative non-significant with maximum and minimum temperature and relative humidity. After 7 days of 1st spraying Costus was at bar with neem oil, after 14 days of spraying Z. oxyphyllum reduced higher than Monocrotophos followed by neem oil.

Among the plant products, highest 100% reduction was indicated by neem oil followed by Eucalyptus ash and *Costus speciosus*. The efficacy of neem oil against aphid is in conformity with the findings of Raja *et al.* (1998) who indicated that neem oil decreases the pest damage in potato as compared to control. The superiority of monocrotophos (0.07%) over the plant products in controlling aphid population was reported by Kulkarni and Mote (1996) who reported that the neem products were found inferior in reducing the pest population as compared to standard check, monocrotophos at 0.07%.

Among the plant products used neem oil 1% was the most effective followed by *Costus speciosus*, *Zanthoxyllum oxyphyllum* and Eucalyptus ash. The present finding is in conformity with Raiganj Surendranath *et al*. (2012) who recorded the effectiveness of neem against leaf hoper in potato. Tariq Niaz (2011) also reported the efficacy of neem against leaf hopper. Monocrotophos was found more effective than all the plant products. A similar confirmation was obtained by Thakur and Singh (199) where application of monocrotophos 0.04% checked leaf hoper population.

The promising plant products *Costus speciosus*, *Zanthoxyllum oxyphyllum* and Eucalyptus ash, used in the present study can be suggested for further research and investigation to bring out an effective measures to control insect pests.

REFERENCES

Asangla, I.T., Alemla, M. and Khound, J,N. (2013), Management practices against Angoumois grain moth, *Sitotroga cerealella* (Olivier) in stored paddy in Nagaland, India. *International Journal of Bio- resource and Stress management* **4** (1), 058-063.

Albert Shitri, I.T., Asangla Jamir. and Pankaj Neog. (2014), Effect of cultivars on the incidence of major insect pests in lowland Rice. *International Journal of Bio- resource and Stress management* **5** (1), 058-063.

Bhushan, V.S., and Sharnappa, A.M. (2009), Survey on insect pests of potato (*Solanum tuberosum* L.) in Medak district of Andhra Pradesh. *Pestology* **33** (11): 36- 40.

Gajendra, S. (1982), Insect pest problems in potato. Indian Farmers' Digest, **15** (8): 37 – 39.

Gulab, Ram, Misra S.S., and Dhamayanthi, K. P. M. (1998), Reaction of different Potato hybrids and varieties against Pests. *Indian Journal of Entomology* **60** (3): 278-285.

Gupta, V.K., Thakur, K.C., Kumar, S., Pandey, S.K., and Sah, U. (2004), True potato seed- An alternative Technology for potato production in North-Eastern Hill region. Tech. Bull. No.64, CPRI, Shimla.

Kishore, Ram, and Misra, S.S. (2001), Relative susceptibility in some advanced hybrids and promising cultivars of potato to cutworm *Agrotis* Spp. in North Western plains. J. App. Zoological Researchers **12** (1): 36-38.

Kishore , R., Singh, B.P., and Parihar, S.B.S. (2003), Population dynamics of White fly (*Bemisia tabaci* Genn.) on potato crop in relation to weather factor. Proceedings of National Academy of Science India Section B. **75** (4): 257- 260.

Kulkarni, A.D., and Mote, V. N. (1996), Efficacy of chitin inhibitors and neem products on sucking pests of cotton. *Plant protection Bulletin* **48** (1- 4): 31- 34.

Mogahed, M. I. (2003), Influence of intercropping on population dynamics of major insect pests of potato (*Solanum tuberosum*) in North Sinai Governorate, Egypt. Indian Journal of Agricultural Sciences **73** (10): 546- 549.

Parihar S.B.S., Verma, K.D., and Singh, R.P. (1994), Studies on some insect pests of potato. *Indian Journal of Entomology* **56** (2): 198-200.

Sharma, P. K., N. P. and Sharma, D. C. (1999), Residual toxicity of some important insecticides against *Amrasca biguttula biguttula* infesting potato. *Journal of Entomological Research* **23** (11): 51- 53.

Raj, B.T. (2002), Crop pest and disease management: Challenges for the millennium. Jyoti publishers, New Delhi pp 61- 71.

Raja, J., Rajendra, B. and Pappiah, C. M. (1998), Advances on IPM for Horticultural crops.Proceedings of the first National Symposium on Pest Management in Horticultural crops, environmental implications and thrusts, Bangalore, India. 15- 17 October 1997.

Satpathy, S., Rai. S. (1999), Efficacy of different pesticides and their combination against leafhopper .Vegetable Science **26** (1): 78-81.

Saini, G. S. (1996), A textbook of vegetables production.Aman publishing house, Meerut pp 29- 42.

Singh G. (1990), Major pest problem of potato in UP hills and their management. *Journal of Indian Potato Association* **17** (1&2): 79-82.

Saxena, A. P., and Singh, V. (1982), Natural enemies of potato pests in India. 349- 355 pp. In potato in Developing countries, B.B. Nagaich (Ed.) 426 p. CPRI Shimla

Tariq Niaz. (2011), Control of jassids and thrips by use of plant extracts. *Pakistan Journal of Bioinformatics*. 1: 2.

Thakur, A K. and Singh, A. K. (1999), Evaluation of neem formulations in comparision to some recommended insecticides against leaf hopper. *Himachal Journal of Agricultural Research* **24** (1/2): *85- 92.*

Verma, K.D., Parihar S.B.S. (2001), Population estimation of green peach aphid, *M. persicae* on potato. *Indian Journal of Entomology* **58** (3): 215-217.

Yadhav, L. D., Nawale, R. N. (1997), Control of whitefly in potato. *Journal of Entomology* **46** (4): 476-478.

Zaki F. A. and Masoodi M. A. (1990), Threatening diseases and pests of potatoes in Jammu and Kashmir. *Journal of Indian potato Association*. **17** (1 & 2): 83-86.

Parihar S.B.S., Verma K.D., and Singh R.P. (1994), Studies on some insect pests of potato *Indian Journal of Entomology* **56** (2): 198.