Volume 1, Number 1, February 2006

# JOURNAL OF NATURAL RESOURCE AND DEVELOPMENT

Society of Biological Sciences and Rural Development
10/96, Gola Bazar, New Jhusi, Allahabad - 211 019 (U.P.)

Volume 1, Number 1, February 2006

# JOURNAL OF NATURAL RESOURCE AND DEVELOPMENT

Society of Biological Sciences and Rural Development

10/96, Gola Bazar, New Jhusi, Allahabad - 211 019 (U.P.)

Vol. 1(1), February 2006

# JOURNAL OF NATURAL RESOURCE AND DEVELOPMENT

Vol. 1, Number 1, February 2006

## CONTENTS

Journal of Natural Resource & Development 1(1):1-4, 2006

# CONCENTRATION IN MILK CONSTITUENTS OF CROSSBRED (JERSEY x SINDHI) COWS AS INFLUENCED BY STAGE OF LACTATION AND FEEDING DIETS

**Raj Sharma, Neeraj And J. Prasad**
*Faculty of Vet. Sci. & A.H., A.A.I.-D.U., Allahabad*

## ABSTRACT

The present investigation is based on concentration of milk constituents (Fat,SNF, TS, Protein. Lactose, Ash, Ca & P) as influenced by stage of lactation and three feeding diets in 24 crossbred cows. Healthy cows of 8 to 10 years age divided into three groups of eight animals in each for three treatments viz., F1 (Wheat bhusa + concentrate), F2 (green fodder + concentrate) and F3 (Wheat bhusa + greens + concentrate). Three stages of lactation of cows were early (upto 3 months), middle(4-7 month) and late (8-10 month). Among the constituents milk fat increasd significantly with the increase in the days of lactation, but protien & lactose decreased with the lactation stage. A non-significant effect of lactation on SNF, TS and water was observed. Ca & P in ash of milk reduced significantly with the stage of lactation.

**Key words :** Concentration, Crossbreed, Lactation Feeding diets.

Milk is nature's perfect food and it's essential for raising the young mammals. The concentration of ingredients in milk influenced by various factors viz. breed, stage of lactation, season, nature of soil, cattle race, type of feeding etc. (Prasad, 2002). Therefore the knowledge of synthesis of milk constituents and secretion in relation to the health and nutritional status in lactating animals is of immense importance. The minerals in milk perform a multitude of fluids. The function of minerals is precisely employed as useful indicator of general physiological stage and mammary metabolism of the lactating animal (Peaker & Faulkner, 1983). Hence, the present study on concentration of milk constituents in milk of crossbred (Jersey x Red sindhi) cows as influenced by stage of lactation and feeding diets was undertaken.

## MATERIALS AND METHOD

The experiment was conducted on 24 healthy crossbred cows of nearly same age (8-10 years) divided into three groups of 8 animals in each for three treatments viz. feeding wheat bhusa + concentrate (F1), green fodder + concentrate (F2) and wheat bhusa + greens + concentrate (F3). Lactation stage of the cows were early (L1), middle (L2) and late (L3) which includes the cows upto three month of laction in L1, cows in 4 to 7 month of lactation in L2 cows in 8 to 10 month of lactation in L3. All the treatments were replicated 8 times in a factorial design of 3x3. The dry and green fodders were fed ad. lib. in the ratio 1:1 to meet the requirement of DCP and TDN for the maintenance and production of milk in cows. The milk samples from cows collected for 21 days and *analyzed for the concentration of fat, protein, lactose, SNF, TS, ash, Calcium and P as per AOAC (1972).

## RESULTS AND DISCUSSIONS

**Fat :** Per cent fat in milk of cows in L1, L2 and L3 stage of lactation was 3.86, 3.50 and 4.13, respectively. Similerly per cent fat in milk of cows under 3 diets viz., F1, F2 and F3 was 3.80, 3.50 and 3.90, respectively. The results showed an increase in fat in milk of cows of F3 diet compared to F1 and F2 diets. These results are in line with the obsrevations of Patle and Mudgal (1976) and Saijpaul *et. al.*, (2005). Some investigators. Abdel *et. al.*, 1977; Kawalkar *et. al.*, 1978 and Kang *et. al.*, 1994 reported a non-significant effect of feeding diets on the fat per cent in the milk of cows which is not in agreement with the result of the present study.

**TABLE 1. Mean value of different milk ingredients as influenced by three lactation stages and feeding diets :**

| Milk components | L1 | L2 | L3 | F1 | F2 | F3 |
|---|---|---|---|---|---|---|
| Fat % | 3.86a | 3.50b | 4.13a | 3.38a | 3.50a | 3.90b |
| Protein % | 3.29b | 2.92b | 2.79b | 3.13b | 2.99a | 2.88a |
| Lactose % | 4.72b | 4.61b | 4.54b | 4.66a | 4.63a | 4.59b |
| Ash % | 0.61a | 0.64b | 0.62a | 0.62a | 0.63b | 0.633a |
| SNF % | 8.51a | 8.56a | 8.27a | 8.38b | 8.46b | 8.50b |
| TS % | 12.23a | 12.14a | 12.27a | 12.14a | 12.18a | 12.33a |
| Water % | 88.05a | 88.02a | 87.71a | 88.25a | 87.87a | 87.66a |
| Ca % | 0.18b | 0.15a | 0.15a | 0.146b | 0.166b | 0.18b |
| P % | 0.16a | 0.153b | 0.14a | 0.13b | 0.14b | 0.16b |

**TABLE 2. Interaction effect between lactation stages (L) and feeding diets (F) :**

| Milk components | Lactation stage (L1) | | | Lactation stage (L2) | | | Lactation stage (L3) | | |
|---|---|---|---|---|---|---|---|---|---|
| | F1 | F2 | F3 | F1 | F2 | F3 | F1 | F2 | F3 |
| Fat % | 3.30a | 3.80a | 4.00a | 3.60a | 3.40a | 3.50a | 4.00a | 3.50a | 4.20a |
| Protein % | 3.38a | 3.26a | 3.24a | 3.04a | 2.94a | 2.80a | 2.98a | 2.79a | 2.61a |
| Lactose % | 4.74a | 4.73a | 4.71a | 4.63a | 4.64a | 4.56a | 4.60a | 4.54a | 4.50a |
| Ash % | 0.62a | 0.61a | 0.61a | 0.63a | 0.66a | 0.65a | 0.61a | 0.63a | 0.63a |
| SNF % | 8.53a | 8.50a | 8.50b | 8.46a | 8.64a | 8.60a | 8.16a | 8.36a | 8.28a |
| TS % | 12.18a | 12.16a | 12.35a | 12.12a | 12.14a | 12.18a | 12.12a | 12.25a | 12.48a |
| Water % | 88.25a | 87.94a | 87.73a | 88.19a | 88.16a | 87.73a | 88.09a | 87.52a | 87.52a |
| Ca % | 0.16a | 0.18a | 0.20a | 0.14a | 0.16a | 0.17a | 0.14a | 0.16a | 0.17a |
| P % | 0.13ab | 0.15cd | 0.16de | 0.14bc | 0.15cd | 0.17ed | 0.12a | 0.14bc | 0.16de |

***NOTE : Similar alphabets on values indicates non-significant differences within the parameters.***

**Protein :** Per cent protein in milk of cows in L1, L2 and L3 stages of lactation was 3.86, 3.50 and 2.79, respectively. Similarly protein in milk of cows under three diets viz., F1, F2 and F3 was 3.13, 2.99 and 2.88, respectively. The differences in protein in milk of cows due to lactation stages and three diets were significant. These results are in agreement with Krishnamurthy (1964), Lal and Mudgal (1972) and Kang et. al., (1994) who also observed significant effect of protein in milk. Nevertheless the results do not tally with the reports of Kawalkar et. al., (1978), who observed non-significant effect of feeding on protein in milk.

**Lactose :** Percent protein in milk of cows in L1,L2 and L3 stages of lactation was 4.72, 4.61 and 4.54 respectively. Similarly percent lactose in milk of cows under 3 diets viz., F1, F2 and F3 was 4.66, 4.63 and 4.59 respectively. The differences in percent lactose in milk of cows due to three lactation and diets were significant. These observations are in line with the reports of Kang et. al., (1994).

**Ash :** Percent ash in milk of cows in L1, L2 and L3 stages of lactation was 0.61, 0.64 and 0.62 respectively. Similarly percent ash in milk of cows on three diets viz., F1, F2 and F3 was 0.62, 0.63 and 0.633 respectively. The amount of ash was low in the beginning and tended to increase with the increase in lactation. Similar findings were also reported by Mathapati and Bhat (1988) and Singh (1988).

**SNF :** Percent SNF in milk of cows in L1, L2 and L3 stages of lactation was 8.51, 8.56 and 8.27, respectively. Similarly percent SNF in milk of cows under

three diets with F1, F2 and F3 was 8.38, 8.46 and 8.50 respectively. The differences in percent SNF in milk of cows due to three diets were significant but due to three lactation stages were non-significant. These results are in line with Lal and Mudgal (1972), Patle and Mudgal (1976), Masubuchi et. al., (1976) and Kang et. al., (1994), who observed significant effect of feeding on SNF.

**TS :** Percent TS in milk of cows in L1, L2 and L3 stages of lactation was 12.23, 12.24 and 12.18 respectively. Similarly percent TS in milk of cows under three diets viz., F1, F2 and F3 was 12.14, 12.18 and 12.33 respectively. The differences in TS percent in milk of cows due to lactation stages, three diets and their interaction were non-significant. These results are not in agreement with Compell and Merilan, (1961).

**Water :** Percent water in milk of cows in L1, L2 and L3 stages of lactation was 88.05, 88.02 and 87.71 respectively. Similarly percent water in milk of cows under three diets viz., F1, F2 and F3 was 88.25, 87.87 and 87.66 respectively. The differences in percent in milk of cows due to three lactation stages, diets and their interaction were non-significant. These results are in agreement with Moss et.al., (1996).

**Ca and P :** Percent calcium in milk of cows in L1, L2 and L3 stages of lactation was 0.18, 0.15 and 0.15 respectively. Similarly percent calcium in milk of cows under three diets viz., F1, F2 and F3 was 0.146, 0.166 and 0.18 respectively. The differences in calcium in milk of cows due to three lactations stages and diets were significant. Percent calcium in milk of cows in L1, L2 and L3 stages of lactation was 0.16, 0.153 and 0.14 respectively. Similarly percent phosphorus in milk of cows under three diets viz., F1, F2 and F3 was 0.13, 0.14 and 0.16 respectively. Since differences in these values were found significant indicating a significant effect of feeding diet on phosphorus content in milk. These results are not in agreement with Phukan et. al., (2002). Similar findings were also reported by Mathapati and Bhat (1988) and Singh (1988).

It was concluded that daily yeild of cows was not influenced by lactation days and the diets. Among the milk constituents milk fat significantly increased with lactation stage, but protein and lactose decreased with lactation stage. Ash, calcium and phosphorus were significantly influenced by the lactation days and diets. A non-significant influence of lactation stages and diets on TS and water content of milk was observed.

## REFERENCES


Abdel-Hamid, L.B,; Teama, Z.Y.A.; Sherief, R.M; Mahram, G.A. and Farang, S.I.(1977). Effect of feeding systems and individuality on milk fat constants. *Annals of Agri. Sci.*, Moshtohar, 7: 103-111.

AOAC(1970). Official method of Analysis of the Association of official analytical chemists, Bemjamin Franklin Washington DC 2004, 11th edn.

Compbell, J.R. Merilan, C.P.(1961). Effect of frequency of feeding on production characteristics and feed utilization in lactating dairy cows. *J. Dairy Sci.*, 44:664.

KANG, S.W.; Lee, W.S.; Jin, S.H.; Lee, S.S. and Ching, S.B.(1994). Effect of feeding lacating Holstein cows on green fodder season on their productivity. RDA-*J. of Agri. Sci.*, Livestock, 36(2): 515-520.

Kawalkar, V.N.; Patle, B.R.; Choudhary, R.A.(1978). Effect of compounding of feed on milk yeild and milk composition in crossbred (*Holstein x Tharpakar*) cows. *Indian J. of Dairy Sci.*, 31(3):289-291.

Krishnamurthy, T.A.(1964). Feeding protein to the lactating animal. *Nutrional J. of Dairy Sci.*, 51:181.

Lal, G.M. and Mudgal, V.D.(1972). Nutrional and seasonal effect on the SNF content of milk of Tharparkar cow. *Indian J. of Anim. Sci.*, 42:760.

Mashubuchi, T.; Watanable, K.; Koike, K. and Ogawa, M.(1976). Effect of level of concentration on voluntary intake of lactating cows. *Bulletin of the National grass land and Institute,* (9): 41-48.

Moss, R.J.; Martin, P.R.;Ansell, J.; Davison, T.M.; Poppi, D.P.; Favell, D.J. and Love, K.F.(1996). Amount and source of protein in concentration fed to high productivity dairy cows in a subtropical system. *Animal Production,* 21: 95-98.

Mathapati, S.S. and Bhat, G.S.(1988). *Indian J. Dairy Sci.*, 47: 171-176.

Patle, B.R. and Mudgal, V.D.(1976). Effect of level of feeding during early lactation on milk yeild and milk

composition of cows. *Indian J. of Animal Sci.*, 46(5): 215-221.

Peaker, M. and Faulkner, A.(1983). *Proc. Nutrional Soc.*, 42: 419-425.

Phukan, M.; Barah, A.; Sharma, B.C. and Baruah, K.K.(2002). Mineral concentration in milk of cross-bred (Jersey x Red Sindhi) cows duriing different days of laction. *Indian J. Anim. Res.*, 36(1): 74-75.

Prasad, J.(2002). Principles and Practices of Dairy Farm mgmt., 4th edn., Kalyani Publisher, Ludhiana.

Saijpaul, S.; Grewal, R.S.; Ravneet, K. and Naik, P.K.(2005). Evaluation of some potential complete ration for economic production in crossbred cows. *Animal Nutrition and Feed Technology*, 5(2): 203-210.

Singh, R. (1988). Recent advances in Baffalo Recommendation of 2nd World Buffalo Congress., held in India, 12-16 Dec. (2): 174-179 and 224-228.

# BIO-EFFICACY OF BOTANICALS, MICROBIALS AND NEWER INSECTICIDES AGAINST TOMATO FRUIT BORER, *HELICOVERPA ARMEGERA* HUBNER

**R. Ramesh and S.P. Ukey***

*Department of Entomology and Agricultural Zoology, Banaras Hindu University, Varanasi-221 005 (U.P.)*
**Department of Entomology, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola - 444 104 (M.S.).*

## ABSTRACT

The ecofriendly insecticides like botanicals, microbials and newer insecticides were evaluated against tomato fruit borer. The scheduled application of endosulfan 0.05% before flower initiation and HaNPV during flowering phase of the crop recorded the lowest per cent of fruit borer infestation (6.18%) and per cent fruit damage (5.62%), it was over 78 percent less than that of untreated control and it was closely followed by spinosad 0.0015% on number basis endosulfan 0.05% on weight basis. All the treatment performed fairly well barring imidacloprid 0.01% and thiamethoxam 0.01%,which recorded the highest percentage of fruit borer infestation and fruit damage. The highest fruit yield of 26.25 t/ha, an increased yield of 115.87 per cent than control was obtained from abamectin 0.002% followed by spinosad 0.0015% (24.60 t/ha). But the abamectin produced a meagre of 1:0.78 ICBR among all treatment owing to higher cost of insecticides, whereas the highest ICBR of 1:23.71 was obtained in endosulfan 0.05% followed by cypermethrin 0.01% (1:21.03) and NSKE 5% (1:20.30) because of their moderatively higher yield and very low cost of insecticides.

**Key words :** Tomato, *Helicoverpa armigera*, NSKE, neem oil, *Btk*, HaNPV, abamectin, spinosad, imidacloprid, thiamethoxam.

Tomato *(Lycopersicon esculentum Mill)* is one of the most important and favourite vegetable crops of the globe due to its immense commercial and nutritive value. The unit area productivity in India is 17 t/ha whereas, its productivity potential is considered to be 30 t/ha (Singhal, 1996). An array of arthropod pests attacks the crop during its different growth stages attributing low productivity in India. Among all pests, the fruit borer, *Helicoverpa armigera* Hubner (Lepidoptera : Noctuidae) is a prolific polyphagus pest of regular occurrence thoughout the world (Consenza and Green, 1979) and responsible for enormous loss to the tune of 5 to 80 per cent under different agro climatic conditions (Tiwari and Krishnamoorthy, 1984). However, Sometimes complete destruction of tomato crop by this pest (Fery and Cuthbert, 1974). It is a devastating pest during Flowerig and fruiting stage and reported to be the major limiting factor in harvesting higher yield and good quality tomato fruits in most parts of our country (Banerjee and Kaloo, 1989). Several insecticides are recommended for the control of this pest from time to time. However, their indiscriminate use has created a number of problems especially insecticidal resistance. The general consensus is, therefore to develop a "Bio-intensive approach" through use of botanicals, microbials and newer insecticides, which are ecofriendly and cost effective. Such studies on tomato will be more fruitful as it is often eaten as raw salad and needs to free from toxic residues. Therefore, the present study was an attempt to assess the effectiveness of ecofriendly insecticides against tomato fruit borer and their impact on yield and ICBR.

## MATERIALS AND METHODS

The field experiment was conducted at the Experimental Farm of Department of Entomology , Dr. PDKV, Akola during wet season of 2002-03. There were 12 treatments (Table 1) including an untreated control replicated thrice in a Randomized Block Design (RBD). The healthy Pusa Ruby seedlings of about 30 days old having uniform size were used for transplanting on hills marked at 60x60 cm in each plot having the size of 3.6x6.0 m. All the agronomic practices as per recommendations were timely followed. The test insecticides were applied five times at fortnightly interval commencing at one month after transplanting. The number of damaged fruits due to fruit

borer and healthy marketable fruits were sorted out from the harvested fruits of individual plots at each picking. They were counted and weighed and accordingly percentage of infested fruits (number basis) as well as fruit damage (weight basis) was calculated. The yield obtained in net plot of each treatment was also recorded. The money received from the sale of tomato fruits, cost of insecticides for its application and labours cost were used for calculating Incremental Cost Benefit Ratio (ICBR) in order to know the economic viability of each treatment. The cumulative data on fruit borer infestation, fruit damage and yield were statistically analyzed after appropriate transformation (Gomez and Gomez 1984).

## RESULTS AND DISCUSSION

The data recorded on per cent fruit damage was found to be least in scheduled application of endosulfan 0.05% before flower initiation and HaNPV @ 250 LE/ha during flowering phase of the crop in both number basis (6.18%) and weight basis (5.62%) and it was 78.95 and 78.03 per cent less damage than that of untreated control. Spinosad 0.0015% (6.45%) was closely followed on number basis whereas, endosulfan 0.05%, cypermethrin 0.01%, spinosad 0.0015% and NSKE 5% on weight basis and they were on par with each other.

The microbials treatments, abamectin 0.002% and *Btk* @ 1.5 ml/lit. were effective but better than botanicals on number basis whereas, NSKE 5% was slightly better on weight basis barring neem oil 1% and jatropha oil 1% in the same order. The newer molecules *viz.*, thiamethoxam and imdacloprid each at 0.01% were least effective on both cases but superior over control. The least impact might be due to inffectiveness of these systemic insecticides against fruit borer, though they afforded efficient control against sucking pests, which ultimately produced healthy plants during early stage and attracted fruit borer larvae during later stage of the crop. The reason for the most effectiveness of $T_{11}$ was that the endosulfan 0.05% during early stage of the crop growth was well taken care of sucking pests like thrips and whiteflies and leaf eating insects as well while HaNPV provided good protection to fruit borer during flowering and fruiting stage, a major pest of this stage.

The performance of endosulfan and HaNPV observed during this investigation is in conformity with the reports of Ganguli *et al.*, (1997) and Sivaprakasam (1998), spinosad by Dey and Somchoudhury (2001), abamectin by Chaudhary and Senapati (2001), *Btk* by Praveen *et al.*, (2001) and NSKE and neem oil by Sachan and Lal (1990), all in line with the results obtained in the present investigation.

The highest yield of 26.25 t/ha was recorded in abamectin 0.002%, It was 115.87 per cent increased yield over control and on par with $T_8$ (24.60%) and $T_{10}$ (24.30 t/ha). Of these treatments, the latter two did not differ significantly from $T_6$, $T_9$ and $T_7$. The newer molecules $T_7$ and $T_9$ had comparatively better influence over yield might be due to their effectiveness in keeping down sucking pests, though ineffective against fruit borer. But this was reverse in case of *Btk*, stood well against fruit borer but least against sucking pests and ultimately registered a marginal yield of 18.85 t/ha. Kashyap and Batra (1987) also reported the low yield of tomato fruit in *Btk* treated plots. Chaudhary and Senapati (2001) who also observed more yield in abamectin and Sivaprakasam (1998) who reported more yield in endosulfan than cypermethrin all are in conformity with the present findings.

The data on ICBR indicated that endosulfan 0.05% (1:23.71), cypermethrin 0.01% (1:21.03) and NSKE 5% (1:20.30) were fetched maximum cost benefit ratio and appeared as the most economically viable treatments owing to their efficiency in controlling insect pests, moderately higher yield and low cost of insecticides incurred on its application. Of the remaining treatments, the order of ICBR were $T_{11}$>$T_4$>$T_5$>$T_6$>$T_8$>$T_7$>$T_9$>$T_3$. The least ICBR of just 1:0.78 was obtained in abamectin, contrast to their yield level, which recorded top among all. The lowest ICBR was due to the fact that, although it afforded better control against insect pests and offered highest yield, the cost of insecticide (Rs. 11,000/lit) drastically reduced their ICBR. The present findings corroborate with that of Patel *et al.*, (1991) and Singh and Narang (1990), who reported that higher ICBR in endosulfan and cypermethrin, respectively.

Hence from the present studies, it could be

## TABLE 1. Effect of treatments on fruit borer infestation, fruit damage, yield and ICBR

| Tr. No. | Treatments | Fruit borer infestation (%) | | Fruit Damage (%) | | Yield of Tomato Fruits | | Economics | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | No. Basis | Decreased (%) over control | Wt. Basis | Decreased (%) over control | Mean Yield (t/ha) | Increased (%) over control | Total cost of treatments (Rs./ha) (A)* | Value of increased yield over control (B)** | Net gain over control C = (B-A) | ICBR (C/A) |
| $T_1$ | NSKE 5% | 11.99 (3.46) | 59.16 | 8.75 (2.96) | 68.31 | 23.49 | 93.17 | 2127.50 | 45320 | 43192.5 | 1:20.30 |
| $T_2$ | Neem Oil 1% | 15.33 (3.91) | 47.79 | 11.55 (3.40) | 58.17 | 19.69 | 61.92 | 3440 | 30120 | 26680 | 1:7.76 |
| $T_3$ | Jatropha Oil 1% | 13.23 (3.64) | 54.94 | 11.73 (3.42) | 57.52 | 16.90 | 38.18 | 3190 | 18960 | 15770 | 1:4.94 |
| $T_4$ | Spinosad 2.5 EC @ 0.002% | 6.45 (2.53) | 78.03 | 8.42 (2.90) | 69.50 | 24.60 | 102.30 | 3265 | 49760 | 46495 | 1:14.24 |
| $T_5$ | Abamectin 1.8 EC @ 0.0015% | 9.81 (3.13) | 66.59 | 9.81 (3.13) | 64.47 | 26.25 | 115.87 | 31645.23 | 56360 | 24714.77 | 1:0.78 |
| $T_6$ | *Bt*k @ 1.5 ml/lit. | 10.14 (3.18) | 65.46 | 10.00 (3.16) | 63.78 | 18.85 | 55.02 | 3527.50 | 26760 | 23232.5 | 1:6.59 |
| $T_7$ | Imidacloprid 17.8 SL @ 0.01% | 18.25 (4.27) | 37.84 | 17.69 (4.21) | 35.93 | 22.59 | 85.87 | 6007.50 | 41720 | 35712.5 | 1:5.94 |
| $T_8$ | Thiamethoxam 25 WS @ 0.01% | 17.65 (4.20) | 39.88 | 18.82 (4.34) | 31.84 | 21.20 | 74.34 | 5090 | 36160 | 31070 | 1:6.10 |
| $T_9$ | Endosulfan 35 EC @ 0.05% | 8.27 (2.87) | 71.83 | 6.29 (2.51) | 77.22 | 23.75 | 95.31 | 1876.50 | 46360 | 44483.5 | 1:23.71 |
| $T_{10}$ | Cypermethrin 25 EC @ 0.01% | 9.06 (3.01) | 69.14 | 6.86 (2.62) | 75.15 | 20.64 | 69.74 | 1540 | 33920 | 32380 | 1:21.03 |
| $T_{11}$ | Endosulfan @ 0.05% BFI and Hz NPV @ 250 LE/ha DFP | 6.18 (2.48) | 78.95 | 5.62 (2.37) | 79.65 | 24.30 | 99.84 | 2754.60 | 48560 | 45805.4 | 1:16.63 |
| $T_{12}$ | Untreated Control | 29.36 (5.42) | - | 27.61 (5.25) | - | 12.16 | - | - | - | - | - |
| | F test<br>SE (m)±<br>CD at 5% CV% | Sig.<br>0.12<br>0.34<br>5.73 | - | Sig.<br>0.20<br>0.60<br>10.61 | - | Sig.<br>0.78<br>2.29<br>6.38 | | | | | |

Figures in parentheses are corresponding $\sqrt{x}$ values. BFI-Before flower initiation; DFP-During flowering phase.

* It includes cost of insecticides, labour and spray pump charges.

** Sale of tomato fruits at current season was Rs. 4000/t.

concluded that abamectin 0.002% and spinosad 0.0015% were most effective against sucking pests as well as fruit borer and also performed well in getting higher yield. But they are lacked behind in ICBR is concerned, in which endosulfan 0.05%, cypermethrin 0.01% and NSKE 5% fetched higher ICBR. Considering cost and management of fruit borer, instead of sole application of abamectin and spinosad, it can be rotated with either HaNPV, Btk, NSKE, endosulfan or cypermethrin in order to get maximum return as well as to prevent insecticidal resistance, because as they have different mode of action.

## REFERENCES


Banerjee, M.K. and Kalloo (1989). Role of phenols in resistance to tomato leaf curl virus, Fusarium wilt and fruit borer in *Lycopersicom. Current Sci.* 58(10) : 575 - 576.

Chaudhary, N. and Senapati (2001). Evaluation of pesticides from different origin synthetic and biological against pest complex of tomato under Terai region of West Bengal. *Haryana J. Horticultural Sci.* 30(3-4) : 274 - 277.

Consenza, G.W. and Green, H.B. (1979). Behaviour of the tomato fruit worm, *Heliothis zea (Biddie)* on susceptible and resistant lines of processing tomatoes. *Horticultural Sci.* 14 : 171 - 173.

Dey, P.K. and Somchoudhary, A.K. (2001). Evaluation of spinosad A + D (Spinosad 48 SC) against iepidopteran pest complex of cabbage and its effect on natural enemies of diamondback moth under field conditions of West Bengal. *Pestology.* XXV(1): 54 - 58.

Fery, R.L. and Cuthbert Jr., F.P. (1974). Resistance of tomato cultivars to the fruit worm, *Heliothis zea* (Boddie). *Horticultural Sci.* 9(5) : 459 - 470.

Ganguli, R.N., Singh, V.V., Dixit, S.A. and Kaushik, U.K. (1997). Efficacy of NPV (nuclear polyhedrosis virus) and endosulfan against tomato fruit borer, *Heliothis armigera. Current Research.* 26(11):210-212.

Gomez, K.A. and Gomez, A.A. (1984). Statistical Procedure for Agricultural Research. An *International Rice Research Institute* Philipines Book. John Wiley and Sons, New York. 307 - 308.

Kashyap, R.K. and Batra, B.R. (1987). Influence of some crop management practices on the incidence of *Helicoverpa armigera* (Hub.) and yield of tomato (*Lycopersicon esculentum*) in India. *Tropical Pest Management.* 33(2) : 166 - 169.

Patel, J.R., Borad, P.K., Ratanpara, H.C. and Shah, B.R. (1991). Need based control of *Helicoverpa (Heliothis) armigera* on tomato with endosulfan. *Indian J. Plant Prot.* 19(1) : 79 - 80.

Praveen, P.M., Dhandapani, N. and Kennedy, J.S. (2001). Efficacy of *Bacillus thuringiensis* var. *kurstaki* (Berliner) formulations for the management of tomato fruit borer, *Helicoverpa armigera* (Hubner). *Pestology.* XXV(9) : 58 - 59.

Sachan, J.N. and Lal, S.S. (1990). Role of botanical insecticides in *Helicoverpa armigera* management. Paper presented in *National Symposium on Problems and Prospects of Botanical Pesticides in IPM*, Jan., 21-22, 1990 at CTRI Rajahmundry (India).

Singh, D. and Narang, D.D. (1990). Control of tomato fruit borer, *Heliothis armigera* Hubner with synthetic pyrethroids. *Indian J. Ent.* 52(4) : 534 - 540.

Singhal, Vikas (1996). *Indian Agriculture.* New Delhi, Vikas Pub. : 244 - 247.

Sivaprakasam, N. (1998). Control of tomato fruit borer, (*Helicoverpa armigera*) by nuclear polyhedrosis virus in comparision with other treatments. *Indian J. agric. Sci.* 68(12) : 801 - 802.

Tewari, G.C. and Krishnamoorthy, P.N. (1984). Yield loss intomato caused by fruit borer. *Indian J. Agric. Sci.* 54(4) : 341 - 343.

# EFFECT OF EXPERIMENTAL *PROCAMALLANUS* INFECTION ON BLOOD GLUCOSE LEVEL OF THE FRESHWATER CATFISH, *CLARIAS BATRACHUS* (LINNAEUS)

**Shashi Ruhela, A.K. Pandey* and A.K. Khare**
*Department of Zoology, Meerut College, Meerut-250001, India*
**Central Institute of Freshwater Aquaculture, Bhubaneswar-751002, India*

**ABSTRACT :**
The effect of experimental *Procamallanus* infection on blood glucose level of the freshwater catfish, *Clarias batrachus* has been studied. Blood glucose level of control catfish fluctuated between 51.10±2.04 and 60.28±1.02 mg/dl. The infected catfish showed a significant ($P < 0.001$) decrease in blood glucose level after 15, 30, 45 and 60 days post-infection. The observed hypoglycemia in the present study has been attributed to the disturbance in carbohydrate metabolism.

**Key words:** *Procamallanus* infection, serum glucose level, *Clarias batrachus*.

Disease in fish is closely linked to environmental stresses. Infected fish will even move to a warmer area for enhancing body temperature as an aid for increasing the rate of inflammatory response. Parasites affect fish population in a variety of ways including stunting of growth, sterility, mortality, emaciation *etc* (Roberts, 2003). Large-scale fish mortality or fish kill frequently occurs in rivers, ponds and tanks due to environmental stresses as well as heavy parasitic infestations. *Procamallanus* is a common nematode parasite in the stomach and intestine of fishes (Sinha, 1988; Zaman and Leong, 1988; Chandra, 1994; Martens and Moens, 1995; Gonzalez-Solis *et al.*, 2002), the intermediate host (vector) of this parasite is copepods (De *et al.*, 1986; Morvec *et al.*, 1993; Chandra and Modek, 1995; De and Maity, 1999, 2000). An attempt has been made to record the effect of experimental *Procamallanus* infection on glucose metabolism of the commercially important freshwater catfish, *Clarias batrachus*.

## MATERIALS AND METHODS

The adult catfish, *Clarias batrachus* (both sexes; average body weight 88.6± 5.86 g) used in the present study were procured from local freshwater ponds as well as markets of Meerut and adjoining districts of western Uttar Pradesh. They were acclimatized to the laboratory conditions for a week before initiating the experiment. The females *Procamallanus*, collected from the longitudinally cut intestine of the catfish, were kept in watch glass filled with saline solution for natural egg laying at 24-27°C. The eggs were kept in Lock-Lewis solution for healthy embryonation. Lock-Lewis solution was changed periodically from the watch glass and 0.1% formalin added to the culture medium to protect the eggs from fungal contamination. Only one dose of 500 embryonated eggs was given for induced infection (De and Maity, 2000). For serum glucose estimation, blood samples were taken from the caudal vein and serum was separated by centrifugation at 3000 rpm. Serum glucose level was estimated using the standard kit. The data were subjected to statistical analysis to test any significant differences between the two groups using Students 't' test.

## RESULTS AND DISCUSSION

The variations in serum glucose levels elicited by *Procamallanus* infection in the catfish have been summarized in Table 1. The blood glucose level of control fishes were observed to be 55.25±2.18, 51.10±2.04, 54.19±1.82 and 60.28±1.02 mg/dl, respectively on day 15, 30, 45 and 60. A significant decline ($P < 0.001$) in serum glucose level of infected *Clarias batrachus* was observed as the values were found to be 36.01±0.50, 30.10±0.77, 40.02±1.62 and 52.18±0.43 mg/dl, respectively on 15, 30, 45 and 60 days post-infection.

The results of this experiment indicate a significant decline in serum glucose level of the catfish ex-

**Table 1 :** Effect of *Procamallanus* infection on serum glucose level (mg/dl) of *Clarias batrachus*

| Group | 15 days | 30 days | 45 days | 60 days |
|---|---|---|---|---|
| Control | 55.25±2.18 | 51.10±2.04 | 54.19±1.82 | 60.28±1.02 |
| Infection | 36.01±0.50* | 30.10±0.77* | 40.02±1.62* | 52.18±0.43* |

Values are mean ± S.E. of 5 specimens. *Significant response $P < 0.001$.

perimentally infected with *Procamallanus*. Hypoglycemia was observed in the infected fish at all the interval that was apparent during the period of first wave of parasitaemia (15 days post-infection). The observed hypoglycemia in the catfish owing to the experimental nematode infection appears to be due to excessive utilization of blood glucose by the parasites for their metabolism. Gupta and Gupta (1986) have also recorded decline in serum glucose level of fish with trypanosome infection. The fall in the serum glucose level has been attributed to disturbance in carbohydrate metabolism during *A. galli* infection in chicks (Rani,1986; Dubinsky *et al*., 1976; Stewart *et al*., 1978; Chauhan, 2002; Chauhan *et al*., 2005a). Srivastava *et al*. (1988) also reported decrease in serum glucose level of the cattle immunized with tick tissue extract of *Baophilus microplus*. The present observation showed hypoglycemia in *Clarias batrachus* with the experimental *Procamallanus* infection. There are reports that parasites secrete various toxic substances via its excretion and secretion into the lumen of the gastrointestinal tract of the host, the leakage of which into plasma affect the biochemical as well as physiological activities of the host (Roberts, 2003; Chauhan *et al*., 2005b; Ruhela *et al*., 2005).

## ACKNOWLEDGEMENT

We are thankful to the Head, Department of Zoology, Meerut College, Meerut, for providing the necessary laboratory facilities to carry out this work.

## REFERENCES

Chandra, K.J. (1994). Infections, concurrent infections and fecundity of *Procamallanus heteropneustes* Ali, parasitic to the fish *Heteropneustes fossilis*. *Environ. Ecol*., 12 : 679-684.

Chandra, K.J. and P.C. Modak (1995). Activity, staging and penetration of first-stage larvae of *Procamallanus heteropneustus*. *Asian Fish. Sci*., 8 : 95-101.

Chauhan, D.K. (2002). Immunopathological studies in experimental ascaridiasis with heavy metal toxicity in W.L.H. chick. *Ph.D. Thesis*. Chaudhary Charan Singh University, Meerut, India.

Chauhan, D.K., S. Ruhela, M. Kumar and S.S. Lal (2005a). Changes in the biochemical parameters of experimental chicks due to *Ascaridia galli* infection. *J. Exp. Zool. India*, 8 : 69-76.

Chauhan, D.K., S. Ruhela, B. Rastogi and A.K. Khare (2005b). Haematological and biochemical changes in catfish, *Clarias batrachus*, carrying parasitic infection of *Procamallanus*. *Biochem. Cell. Arch*., 5 : 11-20.

De, N.C and R.N. Maity (1999). Larval development of *Onchocamallanus bagarii* (Nematoda : Camallinidae) in copepods. *Folia. Parasitol. (Praha.)*, 46 : 53-58.

De, N.C. and Maity, R.N. (2000) Development of *Procamallanus saccobranchi* (Nematoda : Camallanidae), a parasite of a freshwater fish in India. *Folia. Parasitol. (Praha.)*, 47 : 216-226.

De, N.C., R.K. Sinha and G. Mazumdar (1986). Larval development of *Procamallanus spiculogubernaculus* Agarwal, 1958 (Nematoda: Camallanidae) in copepods. *Folia. Parasitol. (Praha.)*, 33 : 51-60.

Dubinsky, P., P. Lestan and M. Rybos (1976). Effect of *A. galli* infection upon components of blood serum of the host fed with cereal nutrition. *Biol. Brillis.*, 31D : 829-838.

Gonzalez-Solis, D., F. Moravec and V.M. Vidal-Martinez (2002). *Procamallanus (Spirocamallanus) chetumalensis* N.Sp. (Nematoda: Camallanidae) from the Mayan sea catfish, *Ariopsis assimilis*, off the Caribbean Coast of Maxico. *J. Parasitol.*, 88 : 765-768.

Gupta, N. and D.K. Gupta (1986). Trypanosome infectivity and changes in the glucose level of two freshwater fishes. *Indian J. Parasitol.*, 10 : 213-215.

Martens, E. and J. Moens (1995). The metazoan ecto- and endoparasites of the rabbitfish, *Siganus sutor* (Cuvier & Valenciennes, 1835) of the Kenya Coast. *Afr. J. Ecol.*, 33 : 405-416.

Moravec, F., A. Kohn and B.M.M. Fernandes (1993). Nematode parasites of fishes of the Parana river, Brazil. Part 3. Camallanoidea and Dracunculoidea. *Folia. Parasitol. (Praha)*, 40 : 221-229.

Rani, K. (1986). Biochemical and immunological responses induced by *Ascaridia galli* in experimental infection of WLH chicks. *M.Phil. Thesis*, Meerut University, Meerut.

Roberts, R.J. (2003). *Fish Pathology.* 3rd Edn. W.B. Saunders, Philadelphia and London.

Ruhela, S., D.K Chauhan and A.K. Khare (2005). Comparative serum biochemical changes in experimental infection of *Procamallanus* in *Clarias batrachus*. In : *Seventh AZRA Conference on Recent Trends in Applied Zoological Researches Towards Food and Nutritional Security and Their Impact on Environment : Challenges Ahead* (February 14-16, 2005). Orissa University of Agriculture & Technology, Bhubaneswar. p. 5.

Sinha, K.P. (1988). *Procamallanus* (Camallanidae : Nematoda) infection in the fish, *Clarias batrachus*. *Environ. Ecol.*, 6 : 1035-1037.

Srivastava, P.S., S.S. Das, Md. Murtuza and S.R.P. Sinha (1988). Biochemical changes in the sera of cattle immunized with tick tissue extract of *Baophilus microplus*. *Indian J. Anim. Sci.*, 58 : 548-551.

Stewart, G.L., F.M. Fisher Jr., E. Ribells, V. Chiapetta and R. Labrum (1978). "*Trichinella spiralis*" alteration of blood chemistry in mouse. *Exp. Parasitol.*, 45 : 287-297.

Zaman, Z. and T.S. Leong (1988). Occurrence of *Procamallanus malaccensis* Fernando and Furtado 1963 in *Clarias batrachus* and *C. macrocephalus* from Kedah and Perak, Malaysia. *Asian Fish. Sci.*, 2 : 9-16.

# EVALUATION OF DIFFERENT SUPPLIMENT AND SUBSTRATE FOR MAXIMUM PRODUCTION OF OYSTER MUSHROOM (*PLEUROTUS FLORIDA*) EGER.

**Yogesh Kumar, P.N. Singh, Ved Ratan and Mukesh Kumar**

*Department of Plant Pathology,*
*Chandra Shekhar Azad University of Agriculture & Technology, Kanpur - 208002*

## ABSTRACT

Five substrates namely : wheat straw, paddy straw, maize stalk, sugarcane baggasse and bajra stalk alone and in the combination of different suppliments gram powder, soybean cake and groundnut cake were tried for maximum yield of *Pleurotus florida* Eger. The maximum yield (985.5 gm) was found when the wheat straw was used alone followed by paddy straw (900.30 gm). The lowest yield (630.0 gm) was recorded from bajra stalk alone. There was significant effect on yield of supplimentation also. The maximum yield (1093.67 gm) was recorded when wheat straw was supplimented with gram powder followed by wheat straw + soybean cake and wheat straw + groundnut cake which was statistically. At par with paddy straw + soybean cake and paddy straw + groundnut cake. The minimum yield (743.0 gm) found when maize stalk was used with groundnut cake.

**Key words :** *Pleurotus florida*, cultivation, substrates, suppliments combinations, yield, fruit bodies.

Amongst the cultivated edible mushrooms *Pleurotus florida* (Eger) is well known mushroom in many parts of the world. Mushroom cultivation is gaining commercial importance in recent years due to increasing global demand for quality protein. Traditionally, it is cultivated on pasteurized wheat and paddy straw, which are widely used as fodder and are thus costly. There is need to evaluate various kinds of plant waste materials for cultivation of *pleurotus spp*, so that alternate sources may be available for its cultivation. Hence, *Pleurotus florida* was cultivated on five substrates alone and in the combination of three supplements.

## MATERIALS AND METHODS

*Five* substrates namely : wheat straw, paddy straw, maize stalk, bajra stalk and sugarcane baggasse were used for cultivation of *Pleurotus florida*. All the substrates were dried and cut into 3-4 cm long pieces and were soaked over night in fresh water. To avoid the any type of infection bavistin 7.0 gm and formalene (40%) 125 ml/100 liter water were added. The substrates were then taken out from water and were spread over cemented floor to drain out excess water. The polythene bags of size 45 × 75 cm of 100 gauge thickness were filled with steeped straw up to a height of 60-65 cm in 4 layers. After each layer spawning was done with grain spawn @ 3 per cent per bag containing 2 kg dry substrates. For this purpose spawn was obtained from Mushroom Research Laboratory of Chandra Shekhar Azad University of Agriculture & Technology, Kanpur. Prepared following the standard technique (Munjal, 1973) all the treatments were replicated four times. These spawned bags were kept in crop room where the temperature ranged between 20° - 25°C alongwith 80-85 per cent relative humidity throughout the crop period.

In case of supplementation, gram powder, soybean cake and groundnut cake were treated in autoclave at 15 lbs psi for 20 minutes. The three best substrates viz., wheat straw, paddy straw and Maize stalk were used. The substrate were sterilized in autoclave at 1.1 kg/cm$^3$ for the one hour after cooling of substrates supplements were added @ 2 per cent dry weight basis. These supplemented substrates were filled in polythylene bags of (75 × 45 cm). Layer spawning was done @ 3 per cent of dry weight of substrates.

These bags were kept in cropping room where the temperature ranged 20° - 25°C alongwith 80-85 per cent relative humidity.

After 15 days of spawning, the bags were completely colonized by mushroom mycelium and polythene was removed. The first flush of sporophores were harvested after 22th days of spawning and the second and third flushes were harvested on 27th and 35th days of spawning respectively. The yield of fruit bodies on fresh weight basis was recorded.

**Table - 1:** Average yield and fruit bodies of (*Pleurotus florida*) from different substrates.

| Name of substrates | Av. no. of fruit bodies/bag | Av. yield in gram per 2 kg dry substrate |
|---|---|---|
| Wheat straw | 46 | 985.50 |
| Paddy straw | 42 | 900.30 |
| Maize stalk | 41 | 710.20 |
| Bajra stalk | 35 | 630.40 |
| Sugarcane baggasse | 36 | 690.30 |
| CD at 5 % level of significance | 2.269 | 35.094 |

## RESULTS AND DISCUSSION

It is revealed from Table 1 that all substrates show significant difference among themselves. The maximum production (985.50 gm) was recorded on wheat straw followed by paddy straw (900.30 gm) and maize stalk (710.20 gm), the minimum yield (630.40 gm) was recorded on bajra stalk. It is also clear that number of fruiting bodies were (46), (42) and (41) were found on wheat straw, paddy straw and maize stalk respectively, where as minimum fruit bodies (35) were found on bajra stalk. This result is similar with the finding of (Upadhyay and Vijay, 1991). Wheat straw as a best substrate was also found for the production of *Pleurotus florida* (Rathore and Thakore, 2004).

It is clear from Table 2 that supplimentation has important role in enhancing the total yield over control. The wheat straw + soybean cake (1105.67 gm) was most efficient followed by wheat straw + gram powder (1093.67 gm), wheat straw + groundnut cake (1089.33 gm) and paddy straw + groundnut cake (1013.33 gm), paddy straw + soybean cake (1009.00

**Table -2 : Effect of suppliments on the yield of *Pleurotus florida***

| Substrate with supplements | Av. no. of fruit bodies | Av. yield in gm/2kg dry substrate |
|---|---|---|
| Wheat straw + Gram powder | 42 | 1093.67 |
| Wheat straw + soybean cake | 54 | 1105.67 |
| Wheat straw + Groundnut cake | 52 | 1089.33 |
| Paddy straw + Gram powder | 49.33 | 997.33 |
| Paddy straw + Soybean cake | 50.00 | 1009.00 |
| Paddy straw + Groundnut cake | 40.00 | 1013.33 |
| Maize stalk + Gram powder | 46.33 | 761.78 |
| Maize stalk + Soybean cake | 50.05 | 750.67 |
| Maize stalk + Groundnut cake | 45.33 | 743.00 |
| Wheat control | 40.10 | 983.33 |
| Paddy control | 38.00 | 794.00 |
| Maize control | 39.33 | 703.33 |
| C.D. at 5% level of significant | 4.00163 | 103.36459 |

gm). The lowest yield (703.33 gm) was recorded when maize straw was used alone. As for as number of fruit bodies are concerned the maximum fruit bodies (54) was found when wheat straw + soybean cake was used. This combination was statistically at par with the combination of wheat straw + groundnut cake. The minimum fruit bodies were found in case of paddy straw + groundnut cake (40.00). Whereas (38.00) fruit bodies were found in paddy straw used as control.

Schisler and Sinden (1963) studied the effect of addition of various organic suppliments on the yield of mushroom and were found higher yield. Bano (1971) tried various pulse (powdered) and cereal grain as suppliments to paddy straw for growing *P. flabellatus* and observed that oat meal and bengal gram powder gave the highest yield. Jandaik (1974) reported that addition of oat meal or 'arhar dal' powder resulted in better yield. Thus the results of the present investigations are in partial accordance with the earlier workers.

## REFERENCES

Munjal, R. L. (1973). Production of quality spawn of *Agaricus bisporus* and *Volvarialla spp. Indian J. Mush.* 1 : 1-4.

Bano, Z. (1971). Cultivation *Pleurotus flabellatus*. secnd *Int. Symp. Pl. Pathol.*, New Delhi, 135.

Jandaik, C.L. (1974). Artificial cultivation of *Pleurotus sajor*-caju. The *Mush. J.*, 22 : 405.

Rathore, V.R.S. and Thakore B.B.L. (2004). Effect of difference substrates on the production and nutritional value of sporophores *Pleurotus florida* (Eager).. *J. Mycol Pl. Pathol.*, 34 (1) : 66 - 68.

Schisler, L.C. and Sinden, J.W. (1963). *Mush. Sci* 5 : 156 - 164.

Upadhayay, R.C. and Vijay, B. (1991). Cultivation of *Pleurotus* sp. during winter in India. *In Mushroom Science* 13, vol. (2) Proceeding of the 13th International congress on science and cultivation of edible fungi.

Journal of Natural Resource & Development 1(1):15-19, 2006

# PHYSICOCHEMICAL ANALYSIS OF SEWAGE WATER AND ITS EFFECT ON SEED GERMINATION AND SEEDLING GROWTH OF *SESAMUM INDICUM.*

**Suman Gupta and D.N. Shukla***
*Department of Botany, A.B.R.P.G. College, Anpara, Sonnbhadra (U.P.)*
**Department of Botany, Allahabad University, Allahabad-211 002 (U.P.)*

## ABSTRACT

An experiment was conducted at Allahabad, during 2001 to study for physicochemical properties of sewage water and its impact on *Sesamum indicum*. Samples taken from Ghaghar Nala, were analysed. *Sesamum indicum* was selected for the study of seed germination and seedling growth. Lower concentration of sewage water was beneficial for germination and seedling growth (till 30%) while higher concentration (as 60%-100%) was harmful.

**Key Words :** Physicochemical analysis, Sewage water, seed germination, *Sesamum indicum*.

The utilization of sewage as fertilizer to increase the crop production, improves the quality of soil and balances the economic condition is achieved by management of sewage. Sewage for irrigating crops may cause metal accumulation in soils to such as extent that they may become toxic to plants.

Sewage sludge has some manurial value mainly as a source of nitrogen, phosphorus and organic contents.

## MATERIALS AND METHODS

Representative sewage samples were collected from the Ghaghar Nala near Kareli at Allahabad. Ten replicates each of the two-litre sample were collected at a time in a glass stoppered bottles between 8 to 10 a.m. from the sampling stations. Colour and odour of the sewage water were observed simply by naked eye and nose by seeing or smelling it. Temperature was recorded by Celsius thermometer. Electronic conductivity meter was used for the measurement of electrical conductance. Organic carbon was determined by Walkey and Block's methods. An automatic oxygen analyser was used to analyse the D.O. and B.O.D. content. The Dichromate Reflux method was used to determine the chemical oxygen demand. Determination of total solids was made by evaporation methods and of suspended solids by using Gooch crucible. Total nitrogen was analysed by micro-kjeldhal method. Phenol disulphonic acid method was applied for the analysis of nitrate, nitrite, urea and ammonia-N. Carbonate was analysed by titration method, chloride content was measured by 'mohr' method. Stannous chloride method was adopted for the analysis of phosphate content. Na and $K_2O$ were determined by flame photometer. 'Ca' by Oxalate method and Ca + Mg by titration with E.D.T.A. (Ethylene diamine tetra acetate). Mg was obtained by the subtraction of Ca from Ca+Mg. Potassium, Iron, Copper and Zinc was analysed, by Atomic Absorption Spectrophotometer.

Seven concentration of Sewage water were made i.e. 0,10,20,30,60,80 and 100 percent. Tap water was used as control. Healthy and surface sterilized seeds of *Sesamum indicum* var. Type 12; were obtained from Allahabad Agricultural Institute Deemed University, Allahabad. First step of study was completed in the petridish and the second step of the study was completed in the pots. Soil used in pots was alluvial and texture of soil was clay loam. The germination tests on *Sesamum indicum* seeds were conducted as per I.S.T.A. method (Anonymous, 1985) by wetting the germination filter paper with polluted Sewage water and with water as control. All the reading wee taken after calculating the average (10, replicates). Similarly at the end of 2nd and 3rd week all the readings were taken. The experiment was conducted in randomized block design with 7 treatments. The comparisons were made using the analysis of variance technique. The sig-

nificance and non-significance of the treatments were tested with the help of F test.

## RESULTS AND DISCUSSION

Temperature of the water bodies increased by increasing the pollution level. Sewage water showed average temperature i.e. 24.9 pH of the water increased by increasing the pollutants it was found that higher the pollution, greater was pH. Average COD value observed in sewage water was 152.9 ppm. The conductivity of water depends upon the concentration of ions and nutritional status. The conductivity of civic sewage between 480-1230 µmhos/cm. The conductivity of the water bodies varies with seasons has been reported by Bilgrami and Dutta (1985).Lower value of E.C. have been recorded during rainy season. The organic carbon content in water bodies are mainly due to dead organic materials. It varied with the seasons and ranged from 22.1-45.7% in civic sewage. Similar results have been reported by Singh and Bhowmick (1985). Maintenance and distribution of biota in aquatic ecosystem largely depends upon the concentration of dissolved oxygen. High dissolved oxygen content is an indication of healthy system. The concentration of DO was found comparatively lower during winter season. It ranged in civic sewage from 1.9-5.3 ppm. The low content of D.O. in raw sewage was due to high organic content. Biochemical demand is expressed in terms of amount of dissolved oxygen required in milligrams per litre for stabilizing the biodegradable organic matter time. It varied with the season and ranged from 38.2-43.5 ppm in civic sewage. Similar findings were observed by Azad *et al.* (1984) (Table-1). Chemical oxygen demand (COD) is a measure of chemically oxidizable organic substance present in an aquatic system. The value of COD in civic sewage was ranging from 140.2-168.5 ppm present observation regarding COD higher in civic sewage reveals the presence of higher quality of chemically oxidizable substances in the sewage. Similar results were recorded by Chattopadhyay et al. (1984) Seasons have been held to cause a pronounced effect on the amount of dissolved gases in water bodies. Somasheker et.al. (1982) The $CO_2$ concentration fluctuated between 1.8-2.9 ppm in civic sewage. Total dissolved solids (TDS) contains suspended particle, soil particle, discharged effluents, decomposed organic matter, and dissolved solids, microscopic organisms etc. It controls the turbidity of water and varies with the season. The amount of chloride in sewage fluctuated between 30.2-137.3 ppm. There is close relation between chloride and microbes of plankton in water bodies. Bilgrami et.al.(1985). The amounts of nitrates and total nitrogen in water bodies have been shown to fluctuate with the season. The N content of sewage water fluctuated between 4.9-169.6 ppm. This is a reflection of the massive amount of organic matter in the sewage. The sewage had greater amount of nitrate-N, it fluctuated between 3.5-42.1 ppm in sewage water. These findings indicate organic matter decomposition and nitrification during the flow and treatment. Similar results were observed by Chatterji et al. (1981) The amount of bicarbonate varied in sewage effluent between 30.8-523.5 ppm. Higher values in sewage water showed that pollutants tend to increase the amount of bicarbonates. According to Mayer (1963) pH of water body increases due to photosynthetic uptake of $CO_2$ available free or bound in $HCO_3$. Phosphorous is one of most important nutrients, which is required by the biota. In sewage water its concentration ranged between 7.8-15.5 ppm. The high values in sewage are supported by similar findings of Sikandar (1987). Sewage showed highest germination and growth on 30 percent concentration. From 60 to 100 percent concentration, germination and growth were less than control. 10 and 20 percent concentration, showed better response than control. Figure (1). There are a number of inhibitors, in sewage water, which produce toxic substances that affect directly seed germination. By these substances osmotic pressure of cell increase and cause plasmolysis. Due to this cells may be destroyed. Lower (below 6) pH leads to dissolution of iron aluminum and manganese in the water in large concentration enough to be toxic to the plant growth. Sewage water is also concerned with the nutrients uptake, and it gave better response than control up to 30 percent concentration.

**Table 1 : Physico-Chemical Properties of Sewage Water At Allahabad (from Ghaghar Nala)**

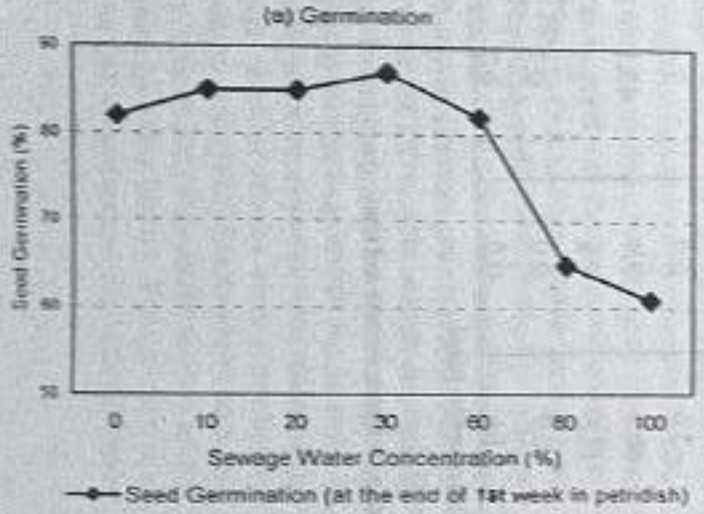
| Sl. No. | Parameters | Values[xx] | | | | CD[x] |
|---|---|---|---|---|---|---|
| | | Season | | | | |
| | | Winter | Summer | Rainy | Average[xxx] | |
| 1. | Colour | Grayish to Black in colour | | | | |
| 2. | Odour | Bad and Soapy | | | | |
| 3. | Temp (°C) | 17.5 | 30.5 | 30.0 | 24.9 | 6.3 |
| 4. | pH | 8.6 | 7.6 | 7.8 | 8.0 | 0.6 |
| 5. | E.C. (µmhos/cm) | 934.0 | 1230.0 | 480.0 | 881.3 | 4.9 |
| 6. | BOD | 38.2 | 43.5 | 39.1 | 38.7 | 13.6 |
| 7. | COD | 150.0 | 168.5 | 140.2 | 152.96 | 14.9 |
| 8. | $CO_2$ | 2.1 | 2.9 | 1.8 | 2.6 | 1.0 |
| 9. | Dissolved Oxygen | 2.2 | 5.3 | 1.9 | 3.1 | 0.3 |
| 10. | Organic Carbon (%) | 45.7 | 30.0 | 22.1 | 32.8 | 3.2 |
| 11. | T.D.S. | 490.0 | 580.0 | 320.0 | 463.0 | 7.8 |
| 12. | Total Nitrogen | 4.9 | 169.6 | 56.5 | 77.0 | 5.1 |
| 13. | Nitrate Nitrogen | 3.5 | 42.1 | 12.0 | 19.2 | 1.2 |
| 14. | Bicarbonate | 523.5 | 250.0 | 30.8 | 267.9 | 2.1 |
| 15. | Carbonate | 1.3 | 6.3 | 2.8 | 3.4 | 2.5 |
| 16. | Chloride | 78.0 | 137.3 | 30.2 | 81.83 | 6.2 |
| 17. | Copper | 0.4 | 1.1 | 0.0 | 0.8 | 1.5 |
| 18. | Iron | 1.8 | 7.6 | 0.9 | 3.4 | 1.1 |
| 19. | Potassium | 30.7 | 60.2 | 28.4 | 40.1 | 2.5 |
| 20. | Phosphate | 10.11 | 15.5 | 7.8 | 8.1 | 2.1 |
| 21. | Manganese | 0.0 | 0.9 | 0.0 | 0.3 | 0.8 |
| 22. | Zinc | 0.8 | 1.4 | 0.0 | 0.7 | 0.6 |

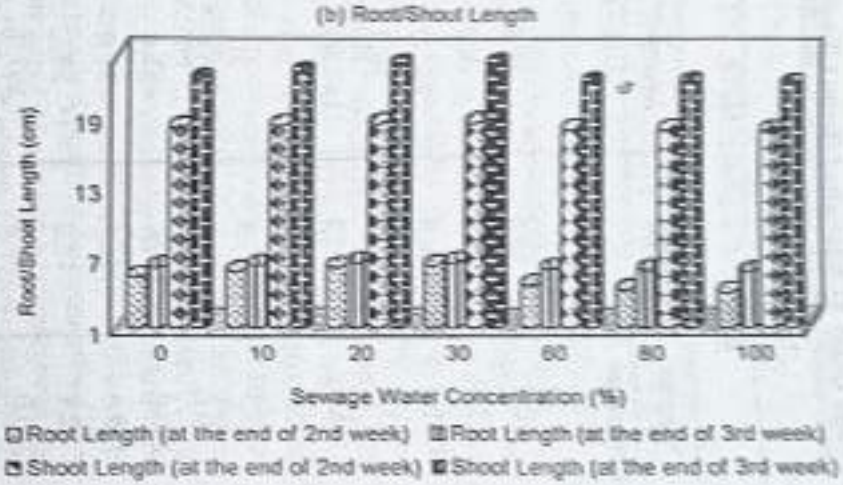
x All the values (except pH) are given in ppm unless otherwise stated.

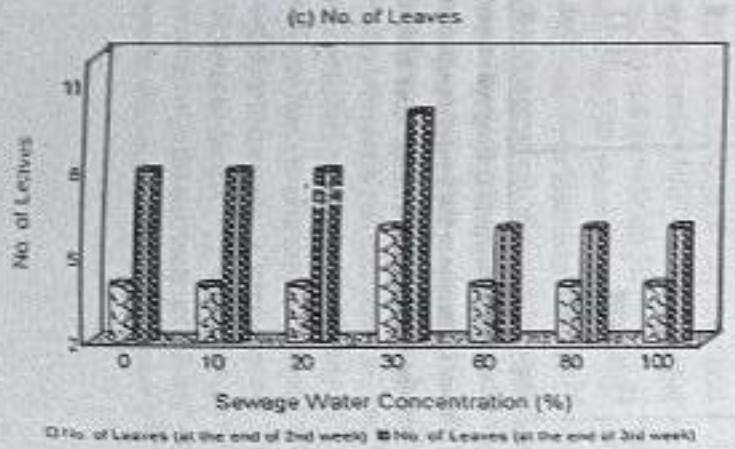
xx Critical Difference at 5% level of significance (p=.05).

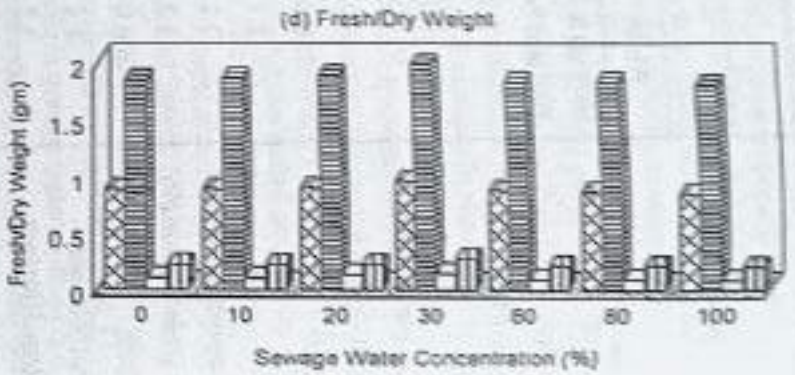
xxx average means annual average value of three season i.e. winter, summer and rainy.

Fig. 01: Effect of Sewage Water on Seed Germination and Seedling Growth of *Sesamum indicum*



## REFERENCES

Anonymous (1985) International Rules for seed testing. *Seed Science and Technology*, 13:322-326.

Azad, A.S., Arora, B.R. and Sekhon, G.S. (1984). Proceedings on water pollution control, Ed. Mandokhot. Department of Soil Science, Hisar.

Bilgrami, K.S. and Dutta, Munshi, J.S. (1985). Ecology of river Ganges (Patna to Farakа). Annual Report, M.A.B. Project, U.N.E.S.C.O.

Bilgrami, K.S.; Bhowmick, B.N. and Singh, A.K. (1986). Impact of abiotic factors on bacterial population of river Ganga. *Pro. Indian Natn. Sci. Acad.*, B52 (4) : 509-514.

Chatterjii, A.; Khan Iqbal, A.; Ali, M. and Mumtaz, Asfa (1981), a study on the ecology of river Kali in Aligarh (India). *Indian J. Animal Res.* 15 (1) : 63-67.

Chattopadhyay, S.N.; Routh, T.; Sharma, V.P.; Arora, H.C. and Gupta, R.K. (1984). A short term study on the pollution status of river Ganga in Kanpur region. *Ind. J. Env. Health*, 26 (3) : 244-257.

Mayer (1963). "The germination of seeds", pergamon press, London.

Sikandar, M. (1987). Ecology of river Ganga in Varanasi with special reference to pollution. Ph.D. Thesis, Banaras Hindu University.

Singh, A.K. and Bhowmick, B.N. (1985). Effect of sewage physico-chemical characteristic and bacterial population of river Ganga at Patna. *Ind. J. Ecol.*, 12 (1) : 17-19.

Somashekar, R.K.; Ramaswamy, S.N. and Govindappa, D.A. (1982). On the extra aquatic fungi from polluted and non polluted waters of River Kapila, Karnataka, *Pro. Indian Natn. Sci. Acad.* 348 (5) : 635-641.

Journal of Natural Resource & Development 1(1):20-26, 2006



# MONITORING WATERLOGGED AREAS USING REMOTE SENSING AND GEOGRAPHIC INFORMATION SYSTEM: A CASE STUDY

**D. K. TRIPATHI**

*Department of Geography, Kamla Nehru Institute of Physical & Social Sciences, Sultanpur (U.P)*

**ABSTRACT :**

Waterlogging is the major land degradation process that restricts the agricultural sustainability and land resource utilization in any irrigated agro-ecosystem. In order to proper management of such type of sick lands, generation of reliable information regarding the nature, extent and spatial distribution is pre-requisite. The modern techniques of Remote Sensing (RS) coupled with Geographic Information System ( GIS) hold a great promise in providing above mentioned informations. In the present study, an attempt has been made to delineate and map the waterlogged areas in a part of Sultanpur district ,Uttar pradesh (Kurebhar Block-26° 14' N to 26° 28' N and 82° 04' E to82° 16'E) using RS data (IRS IC,FCC,LISS III, B-2, 3 & 4,P-102, R-53,scale- 1:50,000, March and October 2003) and GIS packages of ARC-View version 3.2a and ERDAS IMAGIN version 8.5. The Systematic Visual Image Processing (VIP) approach has been used to delineate and monitor the waterlogged areas. To validate the IRS derived waterlogged areas the ground verification survey was carried out in the month of March and October, 2005. Waterlogged area is found to be 2254ha (10.02percent of the total area) in March 2003 and 6828ha (30.35 percent) in October 2003.

**Key Words :** Land degradation process, agricultural sustainability, agro-ecosystem, Remote Sensing, Geographic Information System, systematic visual image processing.

Waterlogging is one of the major land degradation processes that restrict the agricultural sustainability and development in the irrigated agro-ecosystem. In the race of increasing agricultural production to meet the growing demands and rising expectations of living standard of population, the various irrigation schemes have been taken up by Central and State agencies in India. In the most of these irrigation schemes very little efforts have been made for proper drainage (Goal *et al.*, 2005). The over irrigation without adequate drainage, obstruction of natural drainage by way of construction of roads, canals, railways and various other infrastructures had also led the development of water logging condition and subsequent land salinisation and/ alkalization. Some time water logging in the low lying areas are also created due to seepage from canal system. The National Commission for Irrigation (1972), The National Commission on Agriculture and the Ministry of Water Resource (1991) reported waterlogged areas in India are 4.84, 6.00 and 2.46 million ha. respectively. The water logging process has rendered a sizeable area infertile. In order to proper management of these lands and to prevent further deterioration of existing fertile agricultural lands, the reliable information regarding the nature, extent and spatial distribution of water logged area is pre-requisite.

Satellite remote sensing coupled with GIS has a powerful role in monitoring and mapping of waterlogged areas. Several studies have demonstrated the usefulness of RS and GIS techniques in mapping and monitoring of waterlogged and drainage congested areas (Choubey, 1997; Lohani *et al* ., 1999; Dwivedi *et al*., 1999; Sudarsanam *et al*.,2001; Prabhakara *et al*., 2001;Ray *et al*., 2002; Goyal *et al*.,2005). The main objective of this study is to monitor and map the waterlogged lands in study area using IRS IC,LISS III data and GIS software ARC-view 3.2a and ERDAS IMAGIN 8.5.

The study area(Kurebhar block) is located in the northern part of the district Sultanpur (UP) from 26° 14' N to 26° 28' N and 82° 04' E to 82° 16' E occupying an area of 225 $Km^2$ (Fig-1). It forms a


KUREBHAR BLOCK
LOCATION MAP
U.P.
INDIA
SULTANPUR
200 0 200 400K M
4 0 4KM
GOMTI RIVER
BLOCK BOUNDARY
VILLAGE BOUNDARY
2 0 2
KM

FIG. 1

art of fertile Middle Ganga plain and falls under the emi-arid zone. There are 161 revenue villages (including 04 uninhabited). The area receives an average ainfall of 984.64 mm over a period of 49 rainy days, ostly during the months of June, July, August and eptember. The maximum temperature range from 2.2° C (January) to 41.1° C (may). The land in study ea is generally plain and drained by Gomti river. The oils of area under study are mostly sandy loam, and ay loam.

## MATERIALS AND METHODS

### DATA:

In the present study three types of data/information have been used, viz. Satellite data, secondary ata and ground data.

### atellite Data

Indian Remote Sensing Satellite (IRS)- 1 C, inear Imaging Self-Scanning (LISS)-III sensor, False Colour Composite (FCC), Bands-2,3&4, scale :50,000, path-102 and row-53, March and October 003.

**Table-1** IRS IC,LISS- III sensor characteristics Kasturirangan et al., 1996)

| Type | CCD camera |
|---|---|
| Spectral bands (m) | 0.52- 0.59 |
| | 0.62-0.68<br>0.77-0.86<br>1.55-1.70 |
| Ground res.(m) | ~23(VNIR) |
| | ~70 (MIR) |
| | ~140 |
| Swath (km) | ~140 |
| Repetitivety (days) | 24 |

### Secondary Data

a) Survey of India topographical sheet No. 63 J/3 and 63J/7 on 1:50,000 scale.
b) Census Report 2001, Sultanpur
c) Land Revenue Records, 2003.
d) Statistical Handbook, District Sultanpur, 2003.
e) Ground water data, from Ground Water Department, UP , Sharda Shayak Khand 16 and 49, Sultanpur and office of Ex. Engineer (Tubewell), Sultanpur.
f) Soil Survey Report, Sharda Sahayak Command, Sultanpur , District Soil Laboratory and Soil Conservation Department, Sultanpur District

### Ground Data

First hand data collected through Ground Truth Validation Survey, March and October, 2005.

### SORTWARES

- ARCVIEW GIS package , version 3.2a
- ERDAS IMAGIN GIS package, version 8.5.
- MICROSOFT OFFICE version 98

IRS IC, LISS III satellite images of March and October 2003 (path 102 and row 53) acquired on cloud free date covering the study area (Survey of India -SOI Toposheets no. 63 J/3 and 63J/7) were used for the study. The images taken was FCC on 1:50,000 scale having band combinations of $B_2$, $B_3$ & $B_4$ (Green, Red, and Near infrared- NIR).SOI toposheet and village boundary map prepared by NRDMS , Sultanpur were used in generation of base map of study area. The present investigation has to be based on the Visual Image Interpretation (VII) techniques. Different elements of VII such as photo elements (colour, texture, pattern, shape, size, location and association etc.) geotechnical elements (topographic slopes, relief patterns, drainage pattern, irrigation network, ground water conditions, soil and land use patterns etc.) and convergence of evidence were used to get the desired information from satellite imagery. The process of identifying object and features in the image requires sufficient information and background knowledge of the subject and the area under study to discriminate the features from each there in this reference. a formal visit of the area under study for reconnaissance survey was arranged before the image interpretation. However, the identification process requires the consideration of different aspect such as scale of the imagery, resolution characteristics, contrast, photographic processing, the interretation facilities, knowledge of the interpreter etc. (McCloy, 1995). The pre-field interpretation of satellite imagery in the lab was done for identification and mapping of water logged area (pre and post monsoon period) and the details of such objects were then transferred on the base map. The thematic map was prepared using RS data at scale 1;50,000 of the area under study. Different field trips were arranged in due

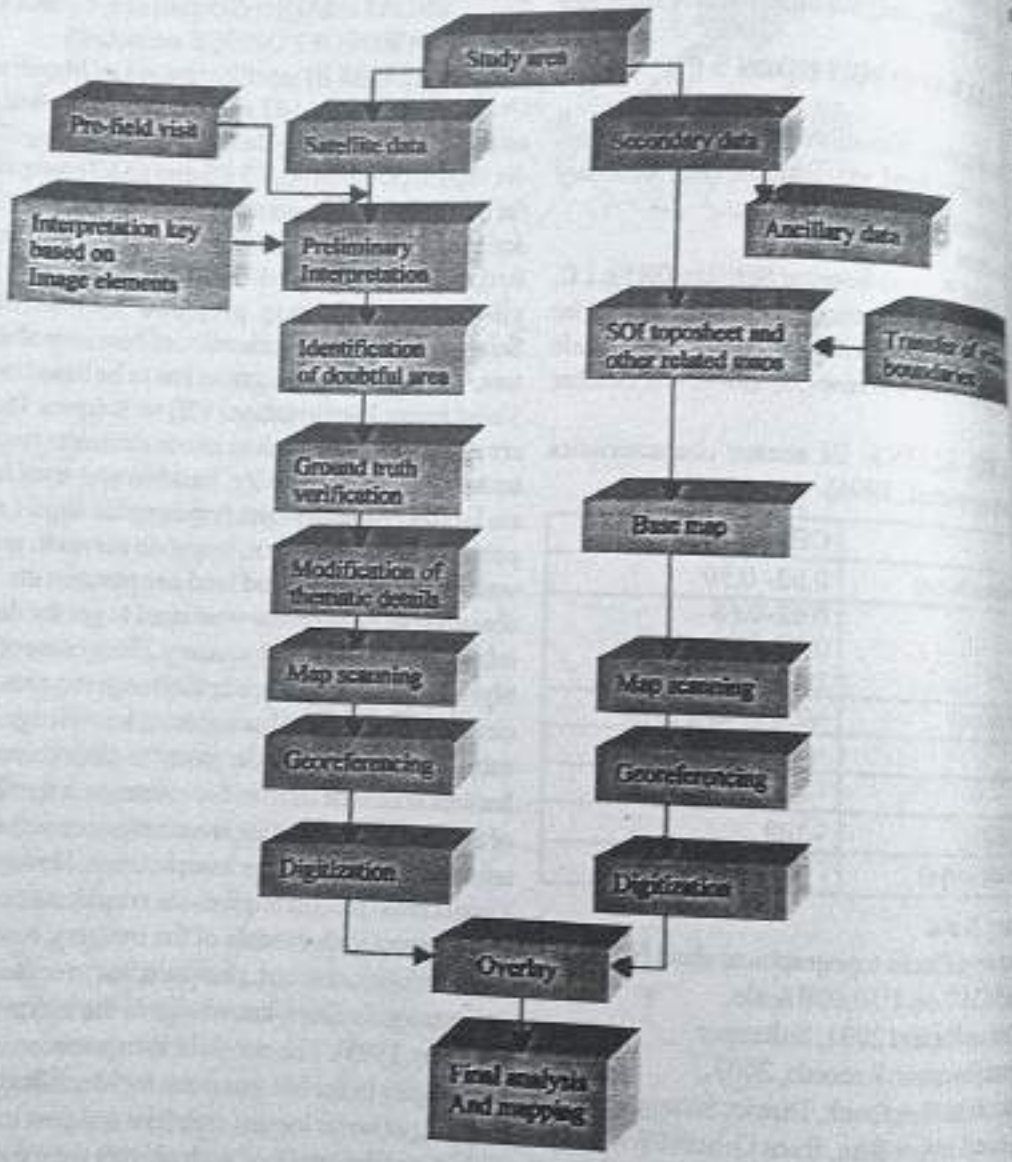



**Fig- Flow chart describes methodology for monitoring and mapping of water logged area**

course of time to collect the ground truth and hydro-meteorological and ground water table depth data and selective field checks for the pre-field interpretation. Thematic traced layers extracted from satellite image and base map were scanned for further processing

The scanned maps were opened in GIS environment for geo referencing, which is a process of stabilizing the relationship between map, and the known real world coordinates. After geo referencing of thematic layers of waterlogged area and base map with village boundaries in ERDAS IMAGINE version 8.5 GIS package, the digitization, editing , displaying , area computation and analysis were carried out using ARC-Viwe version 3.2a GIS software (Flow chart.)

**RESULTS AND DISCUSSION**

Conceptually, water logging refers to a saturated condition for a sufficiently long period so as to affect the growth of most mesophytic plants (Dwivedi *et al*., 1999). An area is said to be waterlogged when the wate table rises to an extent that the soil pores in the root zone of a crop become saturated, resulting in restriction of the normal circulation of air, decline in the level of oxygen and increase in the level of $CO_2$ (Anonymous, 1976). In the present investigation IRS IC, LISS III, FCC imageries of March and October, 2003 were interpreted to identify and delineate the permanent and seasonal waterlogged area, respectively using VII techniques coupled with selective field checks. Although, water logging due to a rising groundwater table does not seem to be detectable with space borne multispectral data, but surface pounding or a thin film of surface water or surface wetness can be easily detected using RS data (Dwivedi *et al*., 1999). As the study area receives rainfall during mid June to late October, in standard FCC prints generated from spaceborne multispectral data acquired during October the seasonal water logging areas show very clearly in different shades of blue to cyan. The area, which remains, waterlogged during both pre and post monsoon seasons qualify as permanent water logged area.

In study area, water logging has become a serious environmental problem, thereby causing widespread damage to land productivity. In total 40.37 per cent of the total geographical area of the block, is covered with water logging. Seasonal and permanent water logging occupies on 30.35 pre cent (6828ha.) and 10.02 per cent (2254ha.) of the total geographical area respectively in the area under study. The water logged area map obtained form the IRS-1C data is shown in fig-2, and the relevant statistics are given in table -2

The interpreted map demonstrates the wide variation in spatial extent of water logged areas. The major areas affected by water logging in study area can be clearly observed on satellite imagery, mainly along the Sarda canal (Sultanpur branch) and their distributaries. The villages of northern and north-eastern parts namely-Deokali, Bijuri, khemapur, Baithu, Sarangpur, Belgara, Sakardepur, Mahmudpur, Bajhana, Akorhi, Dih dhaggupur, Sewar Chamarkha, Chak Bidar, Chak Mardani, Arwari Kiri Karvat, Kharsoma, Raghupur, Salempur grant, Patna Sangila,

**Table-2 Water logged area using VIP approach.**

| IRS IC data | Water logged area (ha) | % of total area | Image Characteristic |
|---|---|---|---|
| October, 2003 | 6828 (68.28 $km^2$) | 30.35 | light to medium blue tone, tonal variation subject to water spread and organic contents, mottled to rough texture, linear to scattered pattern, varying in size, snaky and irregular in shape, associated with low lying and intensive canal irrigated areas and located along the canals and drains. |
| March, 2003 | 2254 (22.54 $km^2$) | 10.02 | medium to dark blue tone, fine texture, scattered pattern, medium to small size, associated with low laying area with mesophyte plants and poor drainage. |

STUDY AREA
WATERLOGGED AREA
BASED ON IRS 1C LISS-III DATA 2003
INDEX
PERMANENT WATERLOGGING
SEASONAL WATERLOGGING
RAILWAY LINE
ROAD
CANAL
N
E
S
W
2 0 2 4
KM

Ahirani, Ghatampur, Sanwardhir etc. are severely affected by seasonal water logging. It can be identified on the imagery by light to medium blue and cyan colour, mottled to rough texture, scattered to linear pattern, medium to large size and snaky regular and irregular shape. These areas are associated with low lying and intensive canal irrigated areas and located along the canals and drains.

The permanent water logging patches represented by medium to dark tone, fine texture, and scattered pattern, medium to small size on the satellite imagery. the villages of Ramnathpur, Parsa, Buapur, Mahmodpur, Karamdaspur, Dih Dhaggupur, Balrampur, Umari, Arwari Kiri Karvat, Salempur Grant, Dhorahwa, Sanwardihir etc are characterized by low laying area with mesophyte plaints and poor drainage.

The unscientific method and over irrigation, canal seepage, blocked of natural drainage and flat topography (mostly in the northern and north- eastern parts) has contributed to the water logging conditions in the study area. Construction of road network and canal distributaries with out consideration of geomorphologic realities of the region has also facilitated the development of water logging areas in the region.

The study reveals that remotely sensed data (IRS IC,LISS III) in conjunction with field surveys and the knowledge- based criteria followed in GIS is very useful in the monitoring and mapping of water logged areas. Immediate attention to be paid for improving the drainage facilities in water logged areas so that the problem areas are not only improved in agricultural land quality but also their spread in the fertile peripheral land is checked. This would facilitate enhancing the area under rabi crops and increasing agricultural productivity, for better and sustainable livelihood of the people in area under study

## REFERENCES


Anonymous., 1976. Report of the National Commission on Agriculture. Part V,IX and Abridged Report. *Ministry of Water Resources, Gov of India, New Delhi.*

Choubey, V.K., 1997. Detection and delineation of water logging by remote sensing techniques. *J. Indian Soc Remote Sensing.*, 25 (2): 1589-1599.

Dwivedi, R.S.; Sreenivas, K. and Ramana, K.V., 1999. Inventory of salt-affected soil and water logged areas: a remote sensing approach. *Int. J. Remote Sensing*, 20(8):1589-1599.

Goyal, V. C; Jain, S.K and Pareek, Navneet, 2005. Water logging and drainage assessment in Ravi-Tavi irrigation command (J&K) using remote sensing approach. *J. Indian Soc. Remote Sensing.*,33:7-15.

Kasturirangan, K.; Aravamudan, R.; Deekshatulu, B.L.;Joseph George and Chandrasekhar, M.G., 1996. Indian remote sensing satellite IRS- 1C-The beginning of a new era. *Current Science.*, 70(7):495-500.

Lohani, A.K.; Jaiswal, R.K. and Jha, R., 1999. Water logged area mapping of Mokama Group of Tals using remote sensing and GIS.J *of Institution of Engineers.*,80:133-137.

McCloy, Keith R., 1995. *Resource Management Information System: process and practice* Taylor and Francis:137

Prabhakara, J.; Gupta K.K.; Sreenivasulu, V. and Vijay Kumar., 2001. Re-estimation of area water logged through GIS technique in a distributary command :a case study. In: Spatial Information Technology: remote Sensing and Geographical Information System (Ed. Muralikrishna). BS Pub., Hyderabad: 321 318.

Ray, S.S.; Dadhwal, V.K. and Navalgund, R.R., 2002 Performance evaluation of an irrigation command area using remote sensing : a case study of Mahi command, Gujarat. India. *Agricultural Water Management.*,56:81-91

Sudarsanam , M.S., Singh, R.and Garg, P.K., 2001 Mapping water-logged area. *GIS Development Magazine.*

Journal of Natural Resource & Development 1(1):27-35, 2006

# STUDIES ON THE TRANSMISSION OF SUNFLOWER MOSAIC POTYVIRUS (SMPV) BY APHID *APHIS GOSSYPII* GLOV.

**S.N. Sharma and R.K. Singh***

*Department of Plant Pathology, National Post Graduate College, Barhalganj, Gorakhpur (U.P.)*
**Department of Plant Pathology, Chowdhary Charan Singh Mahavidyalaya, Padmapur, Pandavnagar, Basti (U.P.)*

**ABSTRACT**

The investigation was carried out on the relationship of sunflower mosaic potyvirus (SMPV) with its aphid vector, *Aphis gossypii* revealed that pre-acquisition fasting of the aphid was essential for the transmission of the virus. The aphids could acquire and inoculate the virus in a very short period of 20 second and 30 second respectively. Though even a single viruliferous aphid per plant was able to transmit the virus, however maximum infection was obtained with 15-20 aphids per plant. The aphids retained the infectivity up to 2 hour beyond which they became non-viruliferous. Based on these studies, the virus-vector relationship was assigned to be "non-persistent" type.

**Key Words :** *Helianthus annuus, Potyvirus, Aphis gossypii.*

Sunflower (*Helianthus annuus* L.) is one of the important oil seed crops of India. During 2000-2001, a virus disease, sunflower mosaic potyvirus (SMPV) was observed in sunflower growing areas of Uttar Pradesh causing mosaic-mottling, systemic chlorotic spots and distortion of leaves (Singh, 2002). This virus is transmitted by *Aphis gossypii* Glov. (Singh *et al.*, 2002) under natural conditions. Since this aphid proved to be an efficient vector under laboratory conditions, further investigations on the virus vector relationship were conducted using this aphid.

## MATERIALS AND METHODS

The pure culture of the virus (SMPV) was maintained on *Helianthus annuus* L. var. 'Morden' in an insect proof glasshouse at IARI Regional Station, Pune. Virus free colonies of aphids, *Aphis gossypii* Glov., were reared on healthy Okra (*Abelmoschus esculentus*) seedings. Unless mentioned otherwise, nymphs and apterous adults were employed in these experiments. Transmission tests with aphids were conducted from young infected plants exhibiting severe systemic symptoms as virus source. *H. annuus* var. 'Morden' seedlings were used as test plant as first true leaf stage in all the experiments. For acquisition feeding, aphids kept in petri dishes. During transmission feeding, the aphids on the test plants were covered with lantern globes with muslin cloth tide on the top. The viruliferous aphids, after specified treatment, were transferred to the test plants with the aid of camel-hair brush No. 1. During short feedings a magnifying lens was used to observe the aphids when they started feeding and the time was recorded by means of a stop watch. Aphids were killed at the end of the required feeding period by spraying the plants with 0.05% monocrotophos or dimethoate solution. All the experiments were conducted in randomized block design with 3 replication.

## RESULTS AND DISCUSSION

(a) **Effect of pre-acquisition fasting period of the aphid vectors on the transmission efficiency of SMV :** It is evident from the result presented in table -1 showed that no transmission was obtained unless aphids were given pre-acquisition fasting. A low percentage of transmission (6.66%) was obtained when aphids were given pre-acquisition fasting of 10 min. However, as the fasting period was increased there was also an increase in the percentage transmission of the virus. The maximum transmission (80%) was recorded with pre-acquisition fasting period of 60-90 min. It was also observed that with higher fasting periods i.e., 2 to 24 hrs., the percentage transmission decreased gradually and only 13.33% transmission was recorded with 24 hours. of pre-acquisition fasting period.

(b) **Effect of different acquisition feeding period of the aphid vectors on the transmis-**

**sion efficiency of SMV :** The data presented in table - 2 nearly indicate that aphids acquired the virus from infected leaves in a very short time of 20 sec. Even though, the virus was acquired by aphids within 20 sec. however, nevertheless for efficient transmission an acquisition feeding period of 10 to 15 min. was required. The maximum virus transmission (80%) was achieved when the aphids were given the acquisition feeding on virus source for 10 to 20 min. However, there was successful gradual decrease in transmission efficiency of aphids when they given acquisition feeding beyond 20 min.

(c) **Effect of inoculation feeding period of the viruliferous aphid vector on the transmission efficiency of SMV :** The data presented in table - 3 showed that the aphid transmitted the virus to an extent of 6.66% in as short as 30 sec. of inoculation feed on the test plants. The percentage of transmission increase with an increase in inoculation feeding period. The maximum transmission (86.66%) was recorded with 30 minutes to 1 hour of inoculation feeding period. However, prolonged inoculation feeding gradually decreased the transmission efficiency.

(d) **Relation of number of viruliferous aphids per plant to the percentage transmission of SMV :** Even though, a single specimen of aphid was able to transmit to virus (6.66%), however, the maximum transmission (80%) was achieved when 15 to 20 aphids per plant were engaged for virus transmission. It was also noticed that when the number of viruliferous aphids per plant was increased beyond optium (15-20 aphids), the percentage transmission decreased gradually. The detailed data have been furnished in table-4.

(e) **Effect of post-acquisition fasting periods of the aphid vector on the transmission of SMV :** It is obvious from the results furnished in table - 5 that the aphids could remain viruliferous till 2 hrs. beyond which they became non-viruliferous. Maximum infection (86.66%) achieved when the viruliferous aphids were transferred immediately to test plants for inoculation feeding. It was also observed that the transmission efficiency of the aphids decreased gradually with an increase in post-infection time observation periods.

(f) **Persistence/non-persistence of SMV in the insect vectors in successive transfers :** The aphids infected third test plant of the series when a single viruliferous aphid was transferred at an interval of 2-5 min. and up to second test plant in the series when aphids were transferred at 10 min. interval. When the aphids were transferred to test plants at intervals of 15,30 min. only the first plant of the series was infected (table - 6).

Based on the above results it is clear that the relationship of SMV with its aphid-vector *Aphis gossypii* is of non-persistent type.

The true mechanism of non-persistent transmission is not yet completely understood, although it is clear that the biological events that lead to virus infection are related to the peculiar probing behaviour typically observed in aphids. The brief intracellular punctures have been correlated with non-persistent virus transmission (Lopez and Abella, *et.al.*, 1988; Powell, 1991) showing that both virus acquisition and inoculation occur at an epidermal intracellular level. The most generally accepted explanation for the entire process is the ingestion-egestion hypotheses (Harris, 1977). This model proposes that regurgitation of infected sap may be responsible for virus inoculation (Harris and Bath, 1973).

Detailed studies on the relationship of SMV with its aphid vector *Aphis gossypii* revealed that the preliminary fasting was necessary to transmit SMV; shorter the pre-acquisition fasting, lesser was the percentage transmission of the virus. This finding in concurrence with those reported by earlier workers, Watson (1936), Watson and Roberts (1939), Sylvester (1950), Miller (1952), Singh (1981, 1982a, b).

In the present investigations the results obtained can not be interpreted with certainly, but they are compatible with the "inactivator" hypothesis put forth by Watson and Roberts (1939, 1940). As per

this hypothesis, during the process of transmission from one plant to another the virus comes in to contact with some substance which partially or wholly destroy its infectivity. With prolonged infection feeding, the effect of fasting disappears and the amount of inactivator increases resulting in the inactivation of greater amount of virus. On the other hand, if the aphids are not started, the amount of inactivator already present in insect is at its maximum and inactivates larger proportion of the virus taken in during the short infection period.

The experiments conducted on the effect of acquisition feeding period of the aphid vector on the transmission of SMV have shown that the virus could be acquired in a very short period of 20 sec. (Table-2). This indicates that the acquisition threshold varies inversely with the efficiency of transmission. These results are in agreement with those reported by Day and Irzykiewicz (1954), Sylvester (1954), Bradley (1954, 1959), Nagrajan and Ramakrishnan (1971), Singh (1981, 1982 a, b).

The fall in the percentage of infection with longer feeding periods has been explained by Watson and Roberts (1939), Day and Irzykiewicz (1954) on the basis of production of inhibitors in insects during feeding. According to Bradley (1954), however, the formation of salivary sheath during longer feeding intervals prevents the aphids from becoming infective. Bradley (1959) also suggested that constant probing by aphids caused them to loose infectivity primarily, because the virus is scour from the stylets as they penetrate. However, later evidence (Hitchborn, 1958; Namba, 1962) has given no support to the idea that such unequal distribution of these viruses occur. The salivary sheath may render virus non-infectious or may, as Vander Want (1954) suggested, acts as a mechanical barrier to the movement of virus to and from the stylets.

Collar *et al.* (1997) found clear negative correlation between probing time and virus acquisition efficiency. This result agrees with the general idea that aphids transmit non-persistent virus more efficiently during brief probes (Bradley, 1954; Sylvester, 1954).

The experiments conducted on the effect of inoculation feeding period of the aphids in the percentage infection of SMV indicated that *A. gossypii* could transmit the virus in 30 sec. and was found to be more efficient vector of the virus. The percentage of transmission however, increased with an increase in inoculation feeding period of aphids up to 1 hour. Longer inoculation feeding decreased the percentage of transmission (Table-3). It is presumed that the more efficient vector carry a larger quantity of virus which is delivered in to the suscept leaves than in the case of less efficient vector. This may be the reason why a longer inoculation threshold is required in the less efficient vector. The explanation for this may be that most of the aphids, that can cause infections do so within first hour and further increase in the duration of the test plants feeding does not seem to increase the number of infections. Similar reports have been published by Nagrajan and Ramakrishnan (1971), Singh (1981, 1982 a, b).

Inoculation has been reported by several workers to occur after probes as short as 5 sec. on the test plant. Presumably, in these early probes, virus is usually introduced between the transverse walls of epidermal cells. However, introduction intracellularly in to epidermal cells, or in to inderline mesophyll cells is by no means ruled out.

Several authors have shown the usefulness of electronic monitoring techniques to correlate aphid behaviour with plant virus transmission. Scheller and Shukle (1986) found an association between sieve element penetration and the transmission of barley dwarf yellow virus (persistently by aphids) using a A.C. monitor. Electrical penetration graphs are a very useful tool to study non-persistent virus transmission. Powell (1991) used this technique to demonstrate brief acquisition and inoculation of potyviruses. Another study revealed that the different frequency of potential drop production by various aphid species could reflect their respective vector efficiencies (Powell *et.al.*, 1992).

Powell, *et.al.*, (1992) suggested that the transmission efficiency of different aphid vector species may be partially determined by the frequency with which they puncture cell membrances. Collar *et al.* (1997) found that the number of potential drops produced by the aphid during the acquisition access period was correlated positively with PVY transmission efficiency. In

terestingly, the mean duration of the potential drop (and that of any of its sub-phased) apparently did not affect the probability of virus acquisition or inoculation. Powell, *et.al.*, (1995) did not find any relationship between duration of recorded membrane punctures and the transmission of the potyvirus TEV. Collar *et al.* (1997) found that the probability of transmission depends mainly on the presence of virus particles in punctured cells, and is therefore enhanced by a greater number of punctures.

The results of the number of viruliferous aphids to the percentage transmission of SMV are in concurrence with those reported by Freitag and Severin (1945), Nagrajan and Ramakrishnan (1971), Singh (1980, 1981, 1982 a, b). The results confirm views of Watson (1936) and Storey (1939) that the infection produced are local and independent for each aphid and not the result of accumulation of sub-infective dosage from different members of a group and the low percentage of infections obtained with single aphids does not indicate a fixed low standard of efficiency in the vectors, but is due to fluctuations in the infection capacity which can be increased or decreased accordingly to the condition of the experiment.

Studies on the effect of post acquisition starvation of the aphid vector on the transmission of SMV indicated that as the fasting period was increased beyond the optium period, the percentage transmission decreased. Similar results have been reported by Watson and Roberts (1939, 1940), Singh (1981, 1982 a, b), Nagrajan and Ramakrishnan (1971).

In the present studies it is seen that the insects losts their infectivity within 2 hours or less. This may be attributed that due to lack of delayed feeding or without access for infectivity. Presumably under such conditions loss of virus is due mainly to normal inactivation by aging.

Several studies have demonstrated that the retention of inoculability for non-persistent viruses may be greatly enhanced (<30h) when the aphids are not allowed to probe on solid surfaces (Zeyen and B... 1990; Fereres, *et.al.*, 1992), indicating that the ... ity of the complex virion-helper component-... much greater than 5 min. considered in electri... etration graph records. Therefore, the observ... of inoculability must not be understood as a ... process, but as the result of some stylet activi... duced by the aphid during the extracellular styl... way (C wave form). Collar *et al.* (1997) ... that the virus particles may be swept from their ... tion site as a result of some occasional ingestion... tion or salivation events taking place because ... activity of the cibrial or salivary pump. Obviously ... hypothesis needs further research to be confirm... refuted.

The data presented in table-6 indicated ... the serial transfer of viruliferous aphids to the test ... the aphids could infect third plant in the serial ... Similar findings was published by Watson and R... erts (1939, 1940), Singh (1981, 1982 a, b), Nagra... and Ramakrishnan (1971). Day and Irzykow... (1954) observed that the duration of persistan... infectivity of aphids as a bearing on the inactiv... hypothesis.

With many stylet-borne viruses aphids beco... non-infective very rapidly, when they are allowed ... feed on test plants, even in few minutes. It seems p... able that main effect of probing on the plant is to ... virus from the stylet (Bradley, 1959). The role of s... vary secretion in this process has not been establish...

The main reason for attempting to determ... how long aphids retain the ability to infect is in relat... to the spread of virus in the field. In most experim... conditions have not been particularly close to tho... that might exist under field conditions. Howev... Cockebain *et al.* (1963) simulated field conditions ... allowing winged aphids to fly for various times in ... air current.

| | |
|---|---|
| No fasting | 0/15 |
| 0.00 | 0.000 |

**Table 1. Effect of pre-acquisition fasting period of the aphid vector *A. gossypii* on transmission efficiency of SMV (potyvirus)**

| Pre-acquisition fasting period | Total No. of plants infected/inoculated | Percentage of infection | Means of transformed values** |
|---|---|---|---|
| 5 min. | 0/15 | 0.00 | 0.000 |
| 10 min. | 1/15 | 6.66 | 14.872 |
| 15 min. | 1/15 | 6.66 | 14.945 |
| 25 min. | 2/15 | 13.33 | 21.313 |
| 40 min. | 8/15 | 53.33 | 46.911 |
| 60 min. | 12/15 | 80.00 | 63.502 |
| 90 min. | 12/15 | 80.00 | 63.576 |
| 2 hours | 11/15 | 73.33 | 58.928 |
| 4 hours | 9/15 | 60.00 | 50.785 |
| 8 hours | 4/15 | 26.66 | 31.075 |
| 24 hours | 2/15 | 13.33 | 21.365 |

** = Highly significant

S.E.M. = 1.00 C.D. at 5% = 2.95 C.D. at 1% = 3.94

**Table 2. Effect of acquisition feeding period of the aphid vector *A. gossypii* on the transmission of efficiency of SMV (potyvirus)**

| Acquisition feeding period | Total No. of plants infected/inoculated | Percentage of infection | Means of transformed values** |
|---|---|---|---|
| 5 seconds | 0/15 | 0.00 | 0.00 |
| 10 seconds | 0/15 | 0.00 | 0.00 |
| 20 seconds | 1/15 | 6.66 | 14.91 |
| 40 seconds | 2/15 | 13.33 | 21.34 |
| 60 seconds | 4/15 | 26.66 | 31.07 |
| 3 min. | 6/15 | 40.00 | 39.22 |
| 5 min. | 10/15 | 66.66 | 54.74 |
| 10 min. | 12/15 | 80.00 | 63.47 |
| 15 min. | 12/15 | 80.00 | 63.53 |
| 20 min. | 12/15 | 80.00 | 63.45 |
| 30 min. | 10/15 | 66.66 | 54.74 |
| 60 min. | 8/15 | 53.33 | 46.91 |
| 90 min. | 6/15 | 40.00 | 39.21 |

** = Highly significant

S.E.M. = 1.00 C.D. at 5% = 2.94 C.D. at 1% = 3.93

Table 3. Effect of inoculation feeding period of the aphid vector *A. gossypii* on the transmission efficiency of SMV (potyvirus)

| Inoculating feeding period | Total No. of plants infected/inoculated | Percentage of infection | Means of transformed values** |
|---|---|---|---|
| 10 seconds | 0/15 | 0.00 | 0.00 |
| 30 seconds | 1/15 | 6.66 | 14.77 |
| 1 min. | 1/15 | 6.66 | 14.89 |
| 5 min. | 3/15 | 20.00 | 26.54 |
| 10 min. | 10/15 | 66.66 | 54.74 |
| 15 min. | 12/15 | 80.00 | 63.48 |
| 30 min. | 13/15 | 86.66 | 68.65 |
| 1 hour | 13/15 | 86.66 | 68.63 |
| 2 hour | 7/15 | 46.66 | 43.08 |
| 4 hour | 5/15 | 33.33 | 32.25 |
| 6 hour | 3/15 | 20.00 | 26.55 |
| 12 hour | 2/15 | 13.33 | 21.35 |
| 24 hour | 2/15 | 13.33 | 21.39 |

** - Highly significant
S.E.M. = 0.56 C.D. at 5% = 1.65 C.D. at 1% = 2.21

Table 4. Relation of number of viruliferous aphids, *A. gossypii* per plant to the transmission of SMV (potyvirus)

| Number of aphids per plant | Total No. of plants infected/inoculated | Percentage of infection | Means of transformed values** |
|---|---|---|---|
| One | 1/15 | 6.66 | 14.87 |
| Two | 1/15 | 6.66 | 14.74 |
| Three | 2/15 | 13.33 | 21.35 |
| Five | 5/15 | 33.33 | 35.25 |
| Ten | 10/15 | 66.66 | 54.74 |
| Fifteen | 12/15 | 80.00 | 63.50 |
| Twenty | 12/15 | 80.00 | 63.46 |
| Thirty | 11/15 | 73.33 | 58.92 |
| Forty | 8/15 | 53.33 | 46.91 |
| Fifty | 6/15 | 40.00 | 39.23 |

** = Highly significant
S.E.M. = 0.50 C.D. at 5% = 1.50% C.D. at 1% = 2.00

No fasting 13/15 86.66 68.64

Table 5. Effect of post-infection starvation of aphid vector *A. gossypii* on the transmission of SMV (potyvirus)

| Post-infection Starvation period | Total No. of plants infected/inoculated | Percentage of infection | Means of transformed values** |
|---|---|---|---|
| No fasting | 13/15 | 86.66 | 68.64 |
| 10 min. | 12/15 | 80.00 | 63.47 |
| 20 min. | 10/15 | 66.66 | 54.75 |
| 40 min. | 8/15 | 53.33 | 46.91 |
| 60 min. | 5/15 | 33.33 | 35.25 |
| 90 min. | 3/15 | 20.00 | 26.55 |
| 2 hours | 2/15 | 13.33 | 21.33 |
| 4 hours | 0/15 | 0.00 | 0.00 |
| 6 hours | 0/15 | 0.00 | 0.00 |
| 12 hours | 0/15 | 0.00 | 0.00 |

** = Highly significant

S.E.M. - 0.82 C.D. at 5% - 2.45 C.D. at 1% - 3.28

Table 6. Persistence of sunflower mosaic (potyvirus) in its aphid vector *A. gossypii*

| S. No. of individual aphids | Feeding period on test plant of the series | Infections produced on test plants in successive transfers | | | | |
|---|---|---|---|---|---|---|
| | | Serial number of plants tested | | | | |
| | | 1 | 2 | 3 | 4 | 5 |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 1. | 2 min. | + | + | + | - | - |
| 2. | 2 min. | - | - | - | - | - |
| 3. | 2 min. | + | - | - | - | - |
| 4. | 2 min. | - | + | + | - | - |
| 5. | 5 min. | + | + | - | - | - |
| 6. | 5 min. | + | + | + | - | - |
| 7. | 5 min. | - | - | - | - | - |
| 8. | 5 min. | + | - | + | - | - |
| 9. | 10 min. | + | + | - | - | - |
| 10. | 10 min. | + | - | - | - | - |
| 11. | 10 min. | - | + | - | - | - |
| 12. | 10 min. | - | - | - | - | - |
| 13. | 15 min. | + | - | - | - | - |
| 14. | 15 min. | - | - | - | - | - |
| 15. | 15 min. | - | - | - | - | - |
| 16. | 15 min. | + | - | - | - | - |
| 17. | 30 min. | - | - | - | - | - |
| 18. | 30 min. | - | - | - | - | - |
| 19. | 30 min. | + | - | - | - | - |
| 20. | 30 min. | + | - | - | - | - |
| 21. | 1 hour | - | - | - | - | - |
| 22. | 1 hour | - | - | - | - | - |
| 23. | 1 hour | - | - | - | - | - |
| 24. | 1 hour | - | - | - | - | - |
| 25. | 2 hour | - | - | - | - | - |
| 26. | 2 hour | - | - | - | - | - |
| 27. | 2 hour | - | - | - | - | - |
| 28. | 2 hour | - | - | - | - | - |
| 29. | 4 hour | - | - | - | - | - |
| 30. | 4 hour | - | - | - | - | - |
| 31. | 4 hour | - | - | - | - | - |

## REFERENCES


Bradley, R.H.E. (1954). Studies on the mechanism of transmission of potato virus Y by the green peach aphid, *Myzus persicae* (Sulz.) (Homoptera : Aphidae). *Can. J. Zool.* 32 : 64-73.

Bradley, R.H.E. (1959). Loss of virus from the stylet of aphids. *Virology* 8 : 308-309.

Cockebain, A.J., Gibbs, A.J. and Heathcoat, G.D. (1963). Some factors affectingthe transmission of sugarbeet mosaic and pea mosaic viruses by *Aphis fakae* and *Myzus persical*. *Ann Appl. Biol.* 52 : 133-143.

Collar, J.L., Avilla, C. and Fereres (1997). New correlations between aphid stylet paths and non persistant virus transmission. *Environ. Ent.* 26 : 537-544.

Day, M.F. and Irzykiewicz, H. (1954). *On the mechanism of transmission of non persistent plybopathogenic viruses by aphids. Australian J. Biol. Sci.* 7 : 251-273.

Dujovny, G., Usugi, T. and Shohara, K. (1998). Charecterization of a potyvirus infecting sunflower in Argentina. *Plant Disease* 82 : 470-474.

Fereres, A., Blua, M. and Perring, T. (1992). Retention and transmission charecteristics of zucchini yellow mosaic virus by *aphis gossypii* and *Myzus persical* (Homoptera : Aphididae). *J. Econ. Entomol.* 85 : 759-765.

Freitag, J.H. and Severin, H.H.P. (1945). Transmission of celery yellow spot virus by the honey suckle aphid *Rhopalosiphum comii Drd. Hilgardia* 16 : 375-385.

Harris, K.F. (1977). An ingestion-egestion hypothesis of non circulative virus transmission. In : Harris, K.F. and Maramorosch, K. (ed.), Aphids as virus vectors. *Academic, New York*. 165-220.

Hitchborn, J.H. (1958). The distribution of viruses in leaves and their inactivation by alterviolet irradiation. *Ann. Appl. Biol.* 46 : 563-570.

Kolte, S.J. (1985). Sunflower diseases. In : *Diseases of Annual Edible Oilseed Crops.* Vol. III, C.R.C. Press, Florida, 194.

Lopez-Abella, D., Bradley, R.H.E. and Harris, K.F. (1988). Correlation between stylet paths [illegible] during superficial probing and the ability [illegible] aphids to transmit non-persistent viruses, [illegible] 285. In : K.F. Harris (ed.), *Advances in [illegible] ease Vector Research.* Vol. 5, Springer, [illegible] York 251-285.

Miller, P.W. (1952).Relationship to the fast perio[illegible] the aphid transmission of crimble virus of [illegible] berry. *Plant Dis. Reptr.* 36 : 92-93.

Nagrajan, K. and Ramakrishnan, K. (1971). Stud[illegible] on cucurbit viruses in Madras State. II. Vec[illegible] tor-virus relationship of the bitter gourd mo[illegible] saic virus. *Proc. Indian Acad. Sci. Sect.* [illegible] 73 : 84-95.

Namba, R. (1962). Aphid transmission of plant [illegible] ruses from the epidermis and sub-epidermal [illegible] sue : *Myzus persical* (Sulc.)Cucumber mosa[illegible] virus. *Virology* 16 : 167-271.

Powell, G. (1991). Cell membrane punctures durin[illegible] epidermal penetration by aphids : consequence[illegible] for the transmission of two potyviruses. *Ann. Appl. Biol.* 119 : 313-321.

Powell, G., Harrington, R. and Spiller, N.J. (1992).Styet activities and potato virus Y vec[illegible] tor efficiencies by the aphids *Brachycaudus helichrysii* and *Drepanosiphum platanoides*. *Entomol. Exp. Appl.* 62 : 293-300.

Powell, G.,Pirone, T.P. and Hardie, J. (1995). Aphid stylus activities durng potyvirus acquisition from plants and in vitro system that correlate with subsequent transmission. *Eur. J. Plant Pathol.* 101 : 411-420.

Scheller, H.V. and Shukle, R.H. (1986). Feeding behaviour and transmission of barley yellow dwarf virus by Sitobion avenae on Oats. *Ent. Exp. Appl.* 40 : 189-195.

Singh, R.K. (2002). Investigation on viral diseases affecting sunflower (*Helianthus annuus L.*) in India. Ph.D. thesis, Purvanchal University, Jaunpur (U.P.), India. 1-156.

Singh, S.J. (1981). Relationship of pumpkin mosaic virus and its aphids vector, Aphis gossypii Glov. *J. Turkish Phytopath.* 10 : 93-109.

Singh, S.J.(1982a). Studies on transmission of pumpkin mosaic virus aphid (*Aphis craccivori*

*Koch.*). *Zeitschrift fur Pflanzenkrankheiten und Pflenzenschutz* 89 ; 79-87.

Singh, S.J. (1982b). Studies on the relationship of pumpkin mosaic virus with its aphid vector *Myzus persical* Sulc. *Acta Ent. Jugoslavia* 18 : 81-89.

Singh, S.J., Satya Prakash and Singh, R.K. (2002). Relationship of sunflower mosaic potyvirus with its aphid vectors, (Abstr.) In : XIV Annual Confer. & National Semi., Indian Virologial Society, held at Bangalore, 18-20 Jan., 2002, 26.

Storey, R.H. (1939). Transmission of plant viruses by insects. *Bot. Rev.* 5: 240-272.

Sylvester, E.S. (1950). Transmission of Brassica nigra virus by the green peach aphid. *Phytopathology* 40 : 743-745.

Sylvester, E.S. (1954). Aphid transmission of non-persistent plant viruses with special reference to the Brassica nigra virus. *Hilgardia* 23 : 53-58.

Vander Want, J.P.H. (1954).Onderzockingen over virus ziekten van de boon (*Phaseolus vulgaris L.*). Ph.D. thesis, Wageningen Agric. Univ. Wageningen, Netherlands, 1-84.

Watson, M.A. (1936). Factors affecting the amount of infection obtained by aphid transmission of the virus. Hy. III - Phil. *Trans. Roy. Soc. B.* 226 : 456-489.

Watson, M.A. and Roberts, F.M. (1939). A comparative study of the transmission of Hyosyamus virus 3, potato virus Y and cucumber mosaic virus 1 by the vectors *Myzus persical* (Sulz.), *M. circumflexus* (Buckt.) and *Macrosiphum gei* (Koch.). *Proc. Roy. Soc. (London). B.* 127 : 543-576.

Watson M.A. and Roberts, F.M. (1940). Evidence against the hypothesis that contain plant viruses are transmitted mechanically by aphids. *Ann. Appl. Biol.* 27 : 223-227.

Zeyen, R.J. and Berger, P.H. (1990). Is the concept of short retention times for aphid-borer non persistent viruses sound? *Phytopathology* 80 : 769-771.

# BIODIVERSITY OF PLANT PARASITIC NEMATODES OF CHICKPEA IN ALLAHABAD REGION

**Hemlata Pant, Gopal Pandey and D.N. Shukla***

*National Academy of Biological Sciences and Rural Development, New Jhusi, Allahabad - 211 019 (U.P.).*
**Department of Botany, Allahabad University, Allahabad - 211 002 (U.P.).*

## ABSTRACT

Twenty one chick pea growing fields in Allahabad region were surveyed in the year 2002-03. Eight genera of plant parasitic nematodes, viz., *Meloidogyne incognita, Pratylenchus thornei, Rotylenchulus reniformis, Hoplolaimus* sp., *Tylenchulus* sp., *Xiphinema* sp., *Longidorus* sp. and *Heterodera* sp., were found in Allahabad region. Mugari, Ramaipur, Dadari, A.A.I. campus were found to have higher infection of root-knot nematode. All villages show less than 25% disease intensity. Maximum root-knot index was observed in Mugari, Baswar, Dhanua and Ramaipur. Predominant rhizosphere plant parasitic nematode viz., *Pratylenchus thornei, Rotylenchulus reniformis and Meloidogyne incognita were found.*

**Key words :** Biodiversity, chickpea, plant parasitic nematodes.

Chick pea (Cicer arietinum L.) occupies important place in among the pulses. These are consumed various forms in vegetarian diet and are rich source of protien. One of the major factor may greatly help towards maximization of production is the control of plant parasitic nematodes which are responsible for causing 13.7% losses in yield of chick pea (Greco 1987, Sharma and MC Donald, 1990).

Diagnostic survey intended to determined the role of nematodes in crop damage have been a rare occurrence in chick pea. However, in India on the basis of limited surveys, very useful informations have been generated by comparative sampling of healthy plant of chick pea grown in close vicinity to the disease plant. In case of root-knot and other nematode like *Pratylenchus thornei, Rotylenchulus reniformis, Hoplolaimus* sp., *Tylenchulus* nematodes, such type of survey were conducted and relevant informations of the distribution and importance of nematodes on chickpea crops were established. Hence nematode was considered as one of the constraints in the cultivation of this crop in Allahabad region. They are responsible to damage root cause extensive necrosis, lesion and knots reducing grains, quality and quantity, suppress *Rhizobium* nodulation and thereby cutting a part of nitrogen availability to plants and soil and increase the severity of many soil born disease.

Chickpea was infected by *Meloidogyne incognita, Fusarium oxysporum* and *Rhizoctonia bataticola* (Pandey and Singh 1990). Hence authors were motivated to conduct the survey on chickpea in Allahabad region and assed the percentage of infection, root-knot index along with status of plant parasitic nematodes.

## MATERIALS AND METHODS

Survey on plant parasitic nematodes were conducted in the twenty one selected villages. Diseased and healthy root samples of the crop along with 500 g. rhizosphere soil were collected in polythene bags to study the association of nematode with the roots. Root-knot nematode counted and calculated infection index of the chickpea crop. 500 g. of soil from each sample were processed for nematod extraction in the following manner as per method described by Southey (1970). The disease intensity and infection index were calculated by using the formula given below.

$$\text{Disease intensity} = \frac{\text{Number of diseased plant}}{\text{Total number of plant}} \times 100$$

$$\text{Infection index} = \frac{\text{Sum of scores}}{\text{Number of plant} \times 5} \times 100$$

Table-1 : Percentage of chickpea plant infected with root-knot disease in different villages.

| S. N. | Village | Percentage of plant infected | |
|---|---|---|---|
| | | Root-knot | Root-knot index |
| 1. | A.A.I. Campus | 7.00 | 2.40 |
| 2. | Naini Area. | 7.00 | 2.40 |
| 3. | Mugari | 13.00 | 4.60 |
| 4. | Mahuari | 0.00 | 0.00 |
| 5. | Chanaini | 0.00 | 0.00 |
| 6. | Dharua | 5.00 | 3.00 |
| 7. | Baswar | 5.00 | 3.00 |
| 8. | Sarangapur | 2.00 | 0.80 |
| 9. | Dadari | 7.00 | 2.40 |
| 10. | Palpur | 0.00 | 0.00 |
| 11. | Ghoorpur | 5.00 | 3.00 |
| 12. | Gangia | 2.00 | 1.60 |
| 13. | Mohabbatganj | 2.00 | 1.60 |
| 14. | Dhadupur | 0.00 | 0.00 |
| 15. | Dandi | 2.00 | 0.80 |
| 16. | Iradatganj | 7.00 | 2.40 |
| 17. | Sahaspan | 2.00 | 1.60 |
| 18. | Andawa | 2.00 | 0.80 |
| 19. | Ramaipur | 8.00 | 2.60 |
| 20. | Jhusi Area | 5.00 | 2.20 |
| 21. | Badra | 2.00 | 0.80 |
| | **Mean** | **3.95** | **1.71** |

**Table-2 :** Number of villages recording disease in different category of infection

| Disease | Plant category of infection | | | |
|---|---|---|---|---|
| | **0-25** | **26-50** | **51-75** | **76-10** |
| Root-knot | 21.00 | 0.00 | 0.00 | 0.00 |
| Mean | 21.00 | 0.00 | 0.00 | 0.00 |

**Table 3 :** Total number of rhizosphere nematode of various genera in chickpea.

| Sample Number | Place | Meloidogyne incognita | Pratylenchus thornei | Rotylenchulus reniformis | Hoplolaimus sp. | Tylenchulus sp. | Xiphinema sp. | Longidorus sp. | Heterodera sp. |
|---|---|---|---|---|---|---|---|---|---|
| 1. | A.A.I. Campus | 150.00 | 950.00 | 163.00 | ---- | ---- | 20.00 | 1.00 | 10.00 |
| 2. | Naini Area. | 125.00 | 10.00 | ---- | 100.00 | 5.00 | 2.00 | 5.00 | 6.00 |
| 3. | Mugari | 175.00 | ---- | 10.00 | ---- | 2.00 | | | ---- |
| 4. | Mahuari | ---- | ---- | 2.00 | ---- | ---- | | | ---- |
| 5. | Chanaini | ---- | 5.00 | 12.00 | ---- | ---- | | | ---- |
| 6. | Dhanua | 60.00 | 150.00 | ---- | 102.00 | ---- | 2.00 | 1.00 | 2.00 |
| 7. | Baswar | 62.00 | ---- | 12.00 | 102.00 | 20.00 | 15.00 | 7.00 | 6.00 |
| 8. | Sarangapur | 21.00 | 1000.00 | 48.00 | ---- | ---- | 1.00 | ---- | ---- |
| 9. | Dadari | 125.00 | ---- | ---- | ---- | ---- | 2.00 | 1.00 | 2.00 |
| 10. | Palpur | ---- | ---- | 33.00 | ---- | ---- | 4.00 | 3.00 | ---- |
| 11. | Ghoorpur | 9.00 | 358.00 | 55.00 | 48.00 | 10.00 | ---- | ---- | 1.00. |
| 12. | Gangia | 2.00 | 208.00 | 65.00 | 14.00 | 12.00 | ---- | 3.00 | ---- |
| 13. | Mohabbatganj | 3.00 | ---- | 918.00 | ---- | 15.00 | 13.00 | 4.00 | ---- |
| 14. | Dhadupur | ---- | 500.00 | 135.00 | 32.00 | ---- | ---- | 2.00 | 2.00 |
| 15. | Dandi | 3.00 | 70.00 | ---- | 48.00 | ---- | 2.00 | 1.00 | 1.00 |
| 16. | Iradatganj | 7.00 | ---- | 210.00 | 40.00 | ---- | 1.00 | ---- | ---- |
| 17. | Sahasoan | 15.00 | ---- | ---- | 35.00 | 12.00 | ---- | ---- | ---- |
| 18. | Andawa | 20.00 | 2.00 | ---- | ---- | ---- | 1.00 | 2.00 | 1.00 |
| 19. | Ramaipur | 160.00 | 7.00 | ---- | ---- | 10.00 | 3.00 | ---- | ---- |
| 20. | Jhusi Area | 55.00 | ---- | 10.00 | ---- | ---- | 5.00 | ---- | 6.00 |
| 21. | Badra | 12.00 | 10.00 | ---- | 15.00 | ---- | 1.00 | 5.00 | 6.00 |
| | **Total** | **1004.00** | **3270.00** | **1673.00** | **536.00** | **86.00** | **75.00** | **39.00** | **39.00** |
| | **Mean** | **47.80** | **155.70** | **79.60** | **25.50** | **4.09** | **3.57** | **1.80** | **1.80** |

## RESULTS AND DISCUSSION

Higher incidence of root-knot was found to Mugari, Ramaipur, A.A.I. Campus, Naini area, Dadari and Iradatganj, compared to Dhanua, Jhusi area, Baswar, Ghoorpur, Dandi, Mohobatganj, Sarangapur, Badra and Sahasoan. The root-knot index observed was as follows. Mugari (4.60), Baswar (3.00), Dhanua (3.00), Ramaipur (2.60), Iradatganj (2.40) and Jhusi area (2.20). Similar observation made by Pandey and Singh (1990). The disease severity caused by root-knot nematode as so for not much assed in and around Allahabad , but its study appear to essential because of the economic importance of the crop. The intensity of disease caused by this disease is directly related to crop yield. Pandey (1988).

The association of rhizosphere soil nematode like *Meloidogyne incognita, Pratylenchus thornei, Rotylenchulus reniformis, Hoplolaimus* sp., *Tylenchulus* sp., *Longidorus* sp. and *Heterodera* sp. were also predominant in chickpea. Similar observation made by Ali (1995). Pandey and Singh (1990), Walia (1982), Walia and Seshadri (1985), Pandey (1988), Pandey and Singh (1991).

## REFERENCES

Ali, S.S., 1995 : Nematodes problems in chickpea (Book) published by *I.I.P.R. Kanpur,* PP. 1-187.

Greco, N. 1987 : Nematode and their control in chickpea in : The chickpea ends. (Saxena, M.C. Singh, K.B.) wallingford, oxon, U.K. : CAB International. 271-281.

Pandey, G., 1988 : Studies on some aspects of diseases of two pulse crop viz. green gram (*Phaseolus aureus* Roxb.) and Bengal gram (*Cicer arietinum*) D. Phil. Thesis, Allahabad University, P.P. 1-20.

Pandey, G. and Singh, R.B., 1990 : Effect of organic amendments on soil microflora and nematode infestation with special reference to *Meloidogyne incognita* in chickpea , *New Agric.* 1(1): 65-70.

Pandey, G. and Singh, K.P., 1990 : Survey of nematode diseases of chickpea in Allahabad region. *Current Nematology.* 1(1): 77-78.

Sharma, S.B. and Donald, M.C., 1990 : Global status of nematode problems of groundnut, pigeonpea, chickpea , sorghum and pearl millet and suggestions for future work. *Crop. Prot.* 9: 453-458.

Southey, J.F., 1970 : Laboratory method for work with plant and soil nemotode. Technical Bulletin (2). London, Her Majesty's Stationary Office.

Walia, R.K., 1982 : Studies on root-lesion nematode *Pratylenchus sp.* infesting some pulse crops. Ph. Thesis, I.A.R.I., New Delhi.

Walia, R.K. and Seshadri, A.R., 1985 : *International chickpea News Letter,* p.12-31.

Journal of Natural Resource & Development 1(1):40-42, 2006



# PERFORMANCE OF EGGPLANT VARIETIES UNDER HOT SUMMER STRESS CONDITIONS OF NORTHERN PLAINS OF INDIA

**Sunil Kumar Singh, A. K. Pandey*, Shiv Mangal ** and G. Singh**
*Department of Horticulture Udai Pratap Autonomous College, Varanasi - 221002 (U.P.)*
**Indian Institute of Vegetable Research, Varanasi, (U.P.)*
***KVK, Barh, Patna.*

## ABSTRACT

A Field experiment was conducted during 2000-02 in summer season of Vegetable Research Farm of Indian Institute of Vegetable Research, Varanasi to know the performance of various genotypes of eggplant. Among the 30 genotypes, there were much differences in growth and yield attributes due to a biotic stress. Maximum plant height of 125.42 cm was observed in Ram Nagar Giant (Round type) while maximum fresh weight of plant was noted in Small Long White genotype, which was oblong type. Among long group, Nesseppe had significantly maximum fresh weight (943. 58g). Dry weight of shoot (percent basis) was noted maximum in Ram Nagar Giant (52.12%). Significantly maximum number of fruits per plant was produced by Uttra which was oblong type followed by Nurky (15.59) and Punjab Barsati (15.19) both being at par to each other were again from oblong type. The highest yield obtained in Ram Nagar Giant (258.58 q/ha) closely followed by Uttra (248.89 q/ha) and KS-227 (244.69 q/ha).

**Key words :** Stress condition, eggplant, vegetative growth, yields.

In India, there is an urgent need of production of nutritious food in a sustainable manner and improve the farm family income in order to ensure household food security along with nutritional and economic security. Vegetables are a vital source of minerals, vitamins and dietary fibers and thus play important role in human nutrition. Vegetable provides adequate quantity of micronutrients and antioxidants and micronutrients which gives immunity against several diseases and disorders. Eggplant or brinjal *(Solanum melongena L.)* being a member of solanaceae family occupies a place of prominence among Indian vegetables. It is liked by poor as well as by rich people. In the northern plains of the country its only one crop is taken by rainy season planting in the month of July-August which starts fruiting in September-October and continues up to March afterward it goes in senescence due to high temperature. Therefore, the present experiment was comducted to know the performance of different brinjal varities in hot summer conditions of northern plains.

## MATERIALS AND METHODS

The field experiment was carried out at Vegetable Research Farm of Indian Institute of Vegetable Research, Varanasi during 2000-01 and 2001-02 in summer season on soil having average fertility 84.62 kg N, 16.90 Kg. P and 247.97 kg K per hectare. Thirty brinjal varities of different groups like ablong type (Small Long White, S. Anna Purna, Punjab Barsati, Uttra and Nurkey); Long Type (JB-8, Plant Samrat, IVBL-9, Nesseppe, Green Long, VRBH-8-13) and Round Type (KS-227, VRB-12, HOB-104, BR-112, CHBR-1, CHBR-3, BB-3-1, Auspey White Round, Ram Nagar Giant, JB-51, DBR-44, PB-1-1, PB-5-12, EG-0582, SAATHA, White Medium, H-8, Rajendra Green Round and CHBR-2) were planted at 60 x 45 cm spacing in two replications in RBD design. Nursery was raised and seeds were sown on 20th and 18th January and seedlings were transplanted on 26th and 21st February in 2001 and 2002, respectively. All other recommended package of practices was followed similarly for all the genotypes and data were recorded in different attributes along with yield.

**Table 1.** Growth parameters and yield of eggplant.

| | Plant height (cm) | Fresh wt. of shoot (g) | dry wt. of shoot (g) | Number of fruit per plant | Yield (q/ha) |
|---|---|---|---|---|---|
| 1. Small long white | 94.08 | 300.00 | 41.00 | 12.50 | 103.66 |
| 2. Sud Ann purna | 80.12 | 205.00 | 31.09 | 12.77 | 184.59 |
| 3. Punjab Barsati | 60.04 | 240.00 | 30.66 | 15.19 | 207.95 |
| 4. Uttra | 66.42 | 223.42 | 35.15 | 26.56 | 248.89 |
| 5. Nurkey | 74.37 | 167.16 | 45.00 | 15.59 | 124.83 |
| 6. J.B.-8 | 120.00 | 228.87 | 45.08 | | |
| 7. Plant Samrat | 69.97 | 233.08 | 36.52 | 11.15 | 104.27 |
| 8. IV.B.L.-9 | 120.25 | 344.66 | 48.34 | 07.65 | 138.08 |
| 9. Nesseppe | 119.48 | 983.58 | 45.00 | 14.25 | 128.54 |
| 10. Green Long | 87.79 | 314.17 | 46.50 | 09.45 | 092.02 |
| 11. VRBH-8-13 | 100.04 | 271.59 | 41.00 | 03.38 | 082.62 |
| 12. K.S.-227 | 96.72 | 364.08 | 44.50 | 05.81 | 244.90 |
| 13. VRB-12 | 118.72 | 639.99 | 35.25 | 03.57 | 103.88 |
| 14. HOB-104 | 97.71 | 568.49 | 34.50 | 06.37 | 164.70 |
| 15. HR-112 | 93.00 | 316.67 | 45.88 | 04.13 | 110.84 |
| 16. CHRB-2 | 97.08 | 240.58 | 47.00 | 01.98 | 053.63 |
| 17. H-8 | 96.17 | 222.25 | 42.38 | 02.99 | 066.40 |
| 18. CHBR-1 | 105.39 | 265.50 | 46.12 | 02.27 | 080.00 |
| 19. CHBR-3 | 96.71 | 272.25 | 51.00 | 07.54 | 194.79 |
| 20. BB-3-1 | 79.97 | 258.58 | 49.75 | 08.63 | 206.16 |
| 21. SAATHA | 100.00 | 163.67 | 46.62 | 03.31 | 096.44 |
| 22. White Medium | 109.66 | 237.41 | 45.50 | 01.07 | 015.86 |
| 23. **Rajendra Green Round** | 116.08 | 224.89 | 41.00 | 02.34 | 110.34 |
| 24. Auspey White Round | 114.33 | 425.00 | 36.50 | 05.72 | 105.53 |
| 25. Ram Nagar Giant | 125.42 | 269.16 | 52.12 | 05.94 | 258.58 |
| 26. JB-51 | 117.08 | 714.08 | 48.00 | 04.46 | 100.22 |
| 27. DBR-44 | 118.75 | 857.50 | 49.00 | 06.45 | 081.60 |
| 28. PBI-1 | 92.58 | 292.58 | 45.00 | 11.00 | 110.63 |
| 29. PB-5-12 | 78.50 | 316.25 | 40.75 | 08.56 | 087.43 |
| 30. EG-058 | 61.67 | 288.25 | 47.75 | 00.17 | 008.98 |
| SE± | 02.96 | 51.12 | 1.008 | 0.275 | 003.99 |
| CD at 5% | 05.12 | 110.12 | 03.12 | 0.852 | 009.13 |

## RESULTS AND DISCUSSION

### Growth attributes

Pooled data of two years of experimentation revealed that the maximum plant of height among the entire group viz. oblong, long and round group of eggplant cultivars was expressed by Ram Nagar Giant (125.42cm) while the minimum was observed in Punjab Barsati (60.04cm). It was that there was much difference with respect to this attribute. However, there was no significant difference among the cultivars JB-8, IVBL-9, Nessape, VRB-12, Rajendra Green Round, Ram Nagar Giant, JB-51 and DBR-44.

Fresh weight of shoot in oblong group was recorded maximum in Small Long White (300.0g) followed by Punjab Barsati (240.0g) while Nurkey was most inferior with its lowest value of 167.18g only. Among the long group, Nesseppe gave significantly superior fresh weight over other with its value of 943.58g while among the round group, DBR-44 with its value of 857.5g was significantly superior over others.

Dry weight of shoot on percent basis varied significantly among the genotypes of eggplant. However, the maximum dry weight of shoot was noted in Ram Nagar Giant (52.12%) closely followed by CHBR-3 (51.1%) of round ground. The maximum value for this was obtained in Punjab Barsati (30.66%).

### Yield attributes

Pooled data of two years of experimentation revealed that there was significant variation among the various genotypes with respect to number of fruits per plant. The genotype Uttra produce d significantly highest number of fruits per plant (26.56) and proved superiority over rest of the genotypes under study. Nurkey (15.59) and Punjab Barsati (15.19) of same group i.e. oblong group, being at par to each other were second. Few of the genotypes like EG-058, white medium, CHBR-2 and Rajendra Green Round proved to be most inferior as they produced less than 3 fruits per plant.

It was found that there was significant variations for all the growth and yield attributesof eggplant genotypes. In this course of study 30 genotypes of eggplant were grown under hot summer situation. Due to ability and adaptability of these genotypes in such situation, there were much variations in these parameters. These observations are in close conformity with the findings of Awasthi and Dixit (1986) who observed significant reduced values of growth and yield attributes of eggplant in abiotic stress.

### Yield (q/ha)

The maximum yield was obtained in round group of genotype i.e. Ram Nagar Giant (258.58q/ha) closely followed by Uttra (248.89q/ha) and KS-227 (244.69q/ha). Other good yielder were Punjab Barsati and BB-3-1 (table 1).

There were some genotypes, which had very poor performance in this context. In eggplant yield differences among the genotypes in context poor fruit set owing to poor yield due to temperature influence has been reported by several workers (Awasthi and Dixit, 1986; Randhwa *et al.*, 1988 and Mohideen *et al.*, 1977).

## REFERENCES

Awashi, C.P. and Dixit, J. (1986). Effect of varietal variation on the nutritional attributes of fruits of eggplant *(Solanum melongena L.) Progressive Horticulture*, 18: 3-4, 288-291.

Mohideen, M.K.; Muthukrishran, C.R., Rajgopal, A. and Metha, V.A. (1977). Studies ofn the rate of flowering, flower types and fruit set in relation to yielding potential of certain eggplant *(Solanum melongena L.)* varieties with reference to weather conditions. *South India-Horticulture*, 25:2, 56-61.

Randhawa, J.S.; Kumar, J.C. and Chadha, M.L. (1988). Studies on the assessment of pollen tube growth, stigma respectively, pollination and fertilization in eggplant *(Solanum melongena L.) Indian Journal of Horticulture*, 45:3-4, 304-306.

Journal of Natural Resource & Development 1(1):43-45, 2006

# EFFECT OF OIL CAKES ON MUSKMELON WILT *FUSARIUM OXYSPORUM* F.SP. *MELONIS*.

**Rajneesh Kumar Pathak, Suman Shukla and D.N. Shukla**
*Department of Botany, Allahabad University, Allahabad - 211 002 (U.P.)*

**ABSTRACT :**

Five oil cakes *viz.*, neem, mustard, castor, groundnut and mahua were amended with soil against muskmelon wilt caused by *Fusarium oxysporum* f.sp. *melonis*. Neem and mustard at 3% concentration of soil (w/w) were effective as it significantly reducing the wilt incidence. Mahua seed cake was the least effective as compared to control. All the treatments were showed significant reduction of wilt incidence of inhanced the plant growth of muskmelon crop.

**Keywords :**

*Muskmelon, wilt, oil cake, Fusarium oxysporum* f. sp. *melonis*.

Wilt of muskmelon (*Cucumis melo* L.) caused by *Fusarium oxysporum* f. sp. *melonis* (Leach and Currence) Synd. and Hans. is a destructive disease in most muskmelon growing areas. Bhaskaran *et al.* (1971) and Waraitch *et al.* (1976) recorded the incidence of this disease in India. The wilt pathogen being soil-borne in nature is difficult to control chemically and by other means of disease control. The use of organic amendments is one of the successful control methods of soil-borne disease. Both stimulatory and inhibitory effects of soil amendments with decomposable organic matters, especially with oil cakes, have been reported for *Fusarium* sp. (Singh and Singh, 1970; Toussoun *et al.*, 1970; Khanna and Singh, 1974; Singh, 1983; Tiyagi *et. al*, 2002, Kaushal and Siddiqui, 2003). However studies on muskmelon wilt incidence in relation to soil amendment with oil cakes are limited. Kotznelson (1946) had suggested that addition of organic mater to soil may exert an indirect rhizosphere effect by influencing the rate of plant growth. The present studies with organic amendments involving different types of oil cakes were carried out with a view to study their effects on incidents of muskmelon wilt.

## MATERIALS AND METHODS

Pot experiment was conducted during 2004-2005. Sixty three pots of 30 cm. size were taken for experimental purpose. All pots were washed with formalin (4%) and filled with sterilized soil.

The sterilized soil was infested with the vigorously growing culture of *Fusarium oxysporum* f.sp. *melonis* on sand-maize-meal medium in the ratio of 1 : 4 (inoculum : soil). The oil cakes were incorporated into soil @ of 1.0, 2.0 and 3.0 % (w/w) in the upper 15 cm of the infested and uninfested soil, and left for decomposition for 45 days. Subsequently, ten muskmelon seeds of var. 'Pusa Sharabati' were sown in each pot and symptoms were observed during development of disease. The percent disease incidence (PDI) was calculated using the following formula :

$$\text{Percent disease incidence (PDI)} = \frac{\text{Number of wilted plants/pot}}{\text{Total Plant Population/Pot}} \times 100$$

## RESULTS AND DISCUSSION

Data indicated that oil cakes considerably reduced the disease incidence of muskmelon wilt. Soil amended with neem cake was most effective in reducing the incidence of muskmelon wilt (Table -1). Maximum reduction of wilt incidence was found in neem cake followed by mustard cake, castor cake, groundnut cake and mahua cake as compared with control . All these values of disease incidence showed that the most effective concentration of various oil cakes used which has 3 percent. Similar observations were recorded by Singh (1968), Papavizas *et al*, (1970), Gupta *et. al.* (1986) and Kaushal and Siddiqui (2003). It is a well known fact that different oil cakes differ in composition and, therefore, in the rate of decomposition, preference by micro organisms and in the nature of decomposition products (Singh, 1983). Singh and Singh (1970) also reported reduction in *Fusarium* sp. with oil cakes. The oil cakes reduced the wilt incidence may be due to the secretion of toxic chemicals or the release of ammonia or by the secretion of antioxidant phenol or phytosterol. Similar observation made by Zakaria *et.al.* (1980), Krishnamurthy *et.al.* (1959).

**Table 1 : Effect of oil cakes amendments on wilt incidence of muskmelon.**

| Treatment | % wilt incidence | | | Mean |
|---|---|---|---|---|
| | Concentration (%) | | | |
| | 1.0 | 2.0 | 3.0 | |
| Neem | 25.0 (29.94) | 20.0 (26.47) | 10.0 (18.39) | 18.33 (24.93) |
| Mustard | 45.0 (42.12) | 40.0 (39.21) | 35.0 (36.24) | 40.0 (39.19) |
| Castor | 60.0 (50.83) | 55.0 (47.87) | 50.0 (45.0) | 55.0 (47. 90) |
| Groundnut | 72.5 (58.56) | 70.0 (56.94) | 65.0 (53.72) | 69.0 (56.41) |
| Mahua | 85.0 (67.21) | 80.0 (63.43) | 75.0 (60.0) | 80.0 (63.43) |
| Control | 90.0 (71.57) | 90.0 (71.57) | 90.0 (71.57) | 90.0 (71.57) |

| Source | SE (d) | CD (P = 0.05) | (Avg. of 4 replicates) |
|---|---|---|---|
| Oil Cakes | (1.12) | (2.25) | |
| Concentration | (0.86) | (1.75) | |
| Oil cakes × conc. | (1.94) | (3.90) | |

Figures in parentheses are transformed 'Arc sine' values.

## REFERENCES


Bhaskaran, R.; Prasad, N.N. and Kothandaraman, R. (1971). Occurrence of *Fusarium* wilt of muskmelon. *Curr. Sc.* 40 : 171.

Gupta, S.K.; Agarwal, R.K. and Sharma, S.L. (1986). Efficacy of soil amendments in managing stalk rot (*Sclerotinia sclerotiorum*) of caulifolower. *Indian J. Plant. Path.*, 4 : 129 - 131.

Katznelson, H. (1946). The rhizosphere effect of mangles on certain groups of soil microganisms. *Soil Sci.*, 62 : 343 - 354.

Kaushal, V.K. and Siddiqui, M.Z. (2003). Efficacy of some water soluble extract of oil cakes for the control of *Fusarium oxysporum* f.sp. *zingiveri in-vitro*. *Flora and Fauna, Jhansi.*, 9 (2) : 91 - 92.

Khanna, R.N. and Singh, R.S. (1974). Rhizosphere population of *Fusarium* sp. in amended soils. *Indian Phytopath.*, 27 : 331 - 339.

Krishnamurthy, K.; Ramakrishnan, T.N.; Rajgopalan, R.; Swaminathan, M. and Subrahamanyan, V. (1959). The Chemical composition and nutritive value of sesamum seed (*Sesamum indicum*) and its products *Food Sci.*, 8 ; 316 - 39.

Papavizas, G.C., Lewis, J.A. and Adamas, P
(1970). Survial of soil root infecting fungi in
XIV. Effect of amendments and fungicides
bean root rot by *Thivelaviopsis basicola* Pl
*Dis. Reptr.*, 54 : 114 - 118.

Singh, R.S. (1968). Incidence of black scurf of po
toes in oilcake agended soils. *Indi
Phytopath*, 21 : 120-121.

Singh, R.S. (1983). Organic amendments for root d
ease control though management of s
microbioa and host. *Indian J. Mycol. Pl. Pat
13 : I - XVI.

Singh, R.S. and Singh, N. (1970). Effect of oil ca
amendment of soil on population of some
causing species of *Fusarium Phytopath.*
69 : 160 - 167.

Taussoun, T.A. ; Bega, R.V. and Nelson, P.E. (e
(1970). Root Diseases and Soil Borne Path
gens. University of California Pres. pp 251

Tiyagi, S.A. ; Khan, A.B. and Alam, M.M. (200
Biodegradable effect of oil seed cakes on
parasitic nematodes and soil inhibiting fungi
festing *Trigonella foenum - greacum*
*Phasseoulusaurevs. Indian Journal of*

*Nematology*, 32 (1) : 47 - 57.

Waraitch, K.S., Munshi, G.D. and Chohan, J.S. (1976). A new wilt disease of muskmelon in India, *Curr. Sci.*, 45 : 628 - 629.

Zakaria, M.A., Lockwood, L. and Filonow, A.B. (1980). Reduction in *Fusarium* population density in soil to volatile degradation products of oil seeds meal amendments. *Phytopathology*, 70 : 495 - 499.

# *RHIZOBIUM* - LEGUME SYMBIOSES AND NITROGEN FIXATION UNDER SEVERE SOIL ACIDITY AND ALKALINITY CONDITIONS

**C. Appunu and B. Dhar**

*Department of Genetics and Plant Breeding, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi - 221 005 (U.P.)*

## Nitrogen fixation system

Biological nitrogen fixation (BNF) of atmospheric nitrogen is estimated to have accounted for approximately 90 per cent of the 10-14 x $10^7$ metric tons of nitrogen fixed annually in terrestrial environments and remaining 10% was fixed abiotically, primarily by lightning (Gage, 2004). Now human activity, especially the generation of ammonium compounds for agricultural fertilizers, fossil fuel consumption, and increased planting of legumes, contributes an estimated 14 x $10^7$ metric tons of additional fixed nitrogen each year (Vitousek *et al.*, 1997). Significant growth in fertilizer-N usage has occurred in both developed and developing countries (Peoples *et al.*, 1995). The requirements for fertilizer-N are predicted to increase further in the future. BNF is catalyzed by prokaryotes and these group contains large and diverse both eubacteria and archaea (Zehr *et al.*, 2003). The enzyme complex-nitrogenase is responsible for nitrogen reduction. The rhizobia are nitrogen fixing bacteria that form root nodules with legumes and this nodule creates microaerobic environments for normal nitrogen fixation function of nitrogenase enzyme complex. Most of the rhizobia are in either, *Rhizobium*, *Mesorhizobium*, *Ensifer*, *Bradyrhizobium* and *Azorhizobium* in the *Rhizobiaceae* family in the class of alpha-proteobacteria. Rhizobia carry most of the genes specifically required for nodulation and nitrogen fixation either on large plasmids or on symbiosis islands (Kaneko *et al.*, 2002). Interestingly, it has been recently discovered that bacteria from outside the *Rhizobiaceae* can also induce nodules on legumes (Moulin *et al.*, 2001). Currently, the subject of BNF is of great importance because use of chemical nitrogen fertilizers has resulted in soil and water pollution, reduced the microbial activity, and the eutropication of lakes and rivers. The beneficial effect of legume-*Rhizobium* symbiotic relationship in terms of BNF has been of main focus in the recent past as it is an important aspect of sustainable food production and long term productivity.

## Importance of BNF to soil fertility

BNF is an efficient source of nitrogen (Peoples *et al.*, 1995). Legumes are very important both ecologically and agriculturally because they are responsible for a substantial part of the global flux of nitrogen from atmospheric $N_2$ to fixed forms such as ammonia, nitrate, and organic nitrogen. Increased plant protein levels and reduced depletion of soil nitrogen reserves are obvious consequences of legume $N_2$ fixation. Deficiency in mineral nitrogen often limits legume growth, and so symbiotic relationships have evolved between plants and a variety of nitrogen-fixing organisms (Freiberg *et al.*, 1997). *Rhizobium*-legume symbioses are the renewable (Peoples *et al.*, 1995) and

primary source of fixed nitrogen in land based systems (Tate, 1995). The symbioses between *Rhizobium*-legumes are cheaper, non-hazardous and usually more effective agronomic practices for ensuring an adequate supply of N for legume based crop production. Legumes fix atmospheric nitrogen in the range of 200-300 Kg of N $ha^{-1}$ $year^{-1}$(Peoples et al., 1995). Inputs of fixed N for alfalfa, red clover, pea, soybean, cowpea, and vetch were estimated to be about 65-335 Kg of N$ha^{-1}$$year^{-1}$ (Tate, 1995). Yield increases crop planted after harvesting of legumes are often equivalent to those expected from application of 30-80 Kg of fertilizer-N $ha^{-1}$. Mandimba (1995) revealed that the nitrogen contribution of *Arachis hypogea* to the growth of *Zea mays* in inter cropping systems is equivalent to the application of 96kg of fertilizer-N $ha^{-1}$. Based on these above points it clearly reveals that the significance of *Rhizobium*-legume symbioses as a major contributor to natural $N_2$ fixation. Therefore, the following discussion pin points the behavior of these symbioses under severe acidity and alkalinity conditions.

## Environmental conditions

Several environmental conditions are the limiting factors to the growth and activity of $N_2$ fixing plants and their symbionts. A principle of limiting factor states that "the level of crop production can be no higher than that allowed by the maximum limiting factor" (Brockwell *et al.*, 1995). In the *Rhizobium*-legume symbiosis, the process of $N_2$ fixation is strongly related to the physiological state of the host plant therefore, a competitive and persistent rhizobial strain is not expected to express its full capacity for nitrogen fixation if stresses impose limitations on the vigour of the host legume (Thomas *et al.*, 1997).

The most important stresses faced by l... gume nodules and their symbiotic partner are w... ity and alkalinity (Raza *et al.*, 2001). Popula... *Rhizobium* and *Bradyrhizobium* species vary ... tolerance to major environmental factors (K... *al.*, 1993). Salinity is a serious threat to agricu... arid and semiarid regions (Rao and Sharma, ... Zahran, 1999). A given stress may also have ... than one effect; e.g. salinity may act as water ... which affects the photosynthetic rate, or may ... nodule metabolism directly. The most problemat... vironments for the rhizobia are low nutrient stat... acidic and alkali nature of marginal lands (Bot... 1991); consequently screening for tolerant strain... been pursued. BNF systems capable of improv... agricultural productivity while minimizing soil los... ameliorating adverse edaphic conditions are esse...

## Soil acidity and alkalinity effect on *Rhizobium*-legume symbioses

Soil acidity and alkalinity are significant p... lem facing agricultural production in many areas of... world and limits legume productivity (Correa ... Barneix, 1997). Most leguminous plants require ... tral or slightly acidic and alkali soil for growth, es... cially when they depend on symbiotic $N_2$ fixa... (Bordeleau and Prevost, 1994). Legumes and th... rhizobia exhibits varied responses to acidity and al... linity. Correa and Barneix (1997) reported that so... legume species are extremely sensitive to acidity (... *M. sativa*), while others tolerate relatively more ... pH (e.g. *Lotus tenuis*). Soil acidity constrains sym... otic $N_2$ fixation by limiting *Rhizobium* survival ... persistence in soils and reducing nodulation (Bel... *et al.*, 1997). Rhizobia with a higher tolerance to ac...

have been identified (Graham *et al.*, 1992). These strains generally perform better under acidic soil conditions in the field (Graham *et al.*, 1994). Tolerance to high alkalinity has been observed previously for rhizobial strains and Jordan (1984) reported tolerance up to pH 9.5 for *Rhizobiaceae*. Nour *et al.* (1994) found the pH tolerance of rhizobial strains isolated from chickpea (*Cicer arietinum*) to be 10.0, and Shenbagarathi (1993) has reported that *Sesbania procumbens* strain is capable of growing at pH 11.0. The low (<4.0) and high (>8.5) pH tolerant strains of *Bradyrhizobium* demonstrate a comparative advantage over acid and alkali sensitive strains in the ability to nodulate their host legumes (Meghvanshi *et al.*, 2005; Appunu *et al.*, 2005). Strains of a given species markedly varied in their pH tolerance levels. The fast growing strains of rhizobia have generally been considered less tolerant to acid pH than have slowly growing strains of *Bradyrhizobium*. However, Mpepereki *et al.* (1997) stated that the existence of both fast-and slow- growing strains of *Vigna unguiculata* which are tolerant to pH values as low as 4.0 have been isolated. Marked variations are also observed among salt tolerance of different species of rhizobia. While growth of a number of strains of *Bradyrhizobium japonicum* is inhibited at <100mM NaCl, various strains of *Sinorhizobium meliloti* and *Rhizobium leguminosarum* grow at >300mM NaCl. Rhizobia isolated from woody legumes can tolerate up to 500 to 800 mM of NaCl. High salt tolerance also aids in the high pH and temperature tolerance (Kulkarni and Nautiyal, 2000). Several *Rhizobium* species have been reported from salt-stressed soils of India (Tilak *et al.*, 2005) and around the world (Zahran, 1999). The basis for differences in pH tolerance among strains of *Rhizobium* and *Bradyrhizobium* is still not clear (Graham *et al.*, 1994). Rhizobia adapt various mechanisms to survive in the acid and alkali soil conditions (Zahran, 1999). In addition, the genetic basis of tolerance to elevated pH suggests that at least two loci of either megaplasmid or chromosomal location for pH genes are necessary for the growth of rhizobia at elevated pH.

The failure of legumes to nodulate under acid soil conditions is common, especially in soils of pH < 5.0. The inability of some rhizobia to persist under such conditions is one cause of nodulation failure (Bayoumi *et al.*, 1995). Recent reports, however, states that inoculation of tolerant strains improved nodulation, dry matter accumulation and nitrogen content of soybeans under acid (Ozawa *et al.*, 1999; Appunu *et al.*, 2005) and alkali (Meghvanshi *et al.*, 2005) soil conditions. The growth, nodulation and yield of *V. faba* were improved after inoculation with their symbiont *R. leguminosarum* bv *viciae* in acid soils (Carter *et al.*, 1994). It appears that pH sensitive stage in nodulation occurs early in the infection process and that *Rhizobium* attachment to root hairs is one of the stages affected by acidic conditions in soils (Vargas, 1988). Taylor *et al.* (1991) suggested that colonization of soils and soybean roots by *B. japonicum* may be adversely affected by acidity, an effect which will result in reduced nodulation.

The host cultivar-rhizobial strain interaction at acid and alkali pH has also been investigated. Ozawa *et al.* (1999) noted that nodulation and $N_2$ fixation by some strains of *Bradyrhizobium* at acidic pH differ with soybean. Vargas and Graham (1989) examined the cultivar and pH effects on competition for nodule sites between isolates of *Rhizobium* in beans (*P. vul-*

*garis*) under acidic conditions. They found a significant effect of host cultivar, ratio of inoculation, and pH on the percentage of nodule occupancy by each strain. However, it has been suggested (Vargas *et al.*, 1988) onlyone of the symbionts needed to be acid tolerant for good nodulation to be achieved at pH 4.5. The performance of the legume-*Rhizobium* symbioses under acidic conditions is best when their acid tolerant strains were isolated from the acidic soils (Ozawa *et al.*, 1999; Appunu *et al.*, 2005). Rhizobia appear to be varying in their symbiotic efficiency under acidic conditions. Van Rossum *et al.* (1994) compared 12 strains of *Bradyrhizobium* for their symbiotic performance with groundnut in acidic soils and found that some strains were totally ineffective under acidic stress (pH 5.0 – 6.5) while others improved vegetative characters and yields.

The host legume appears to be the limiting factor for establishing *Rhizobium*- legume symbiosis under edaphic stress conditions. Legume species differ greatly in their response to low and high pH with regard to growth and nodulation (Tang and Thomson, 1996). Response of salinity varies greatly; some legumes, e.g. *Vicia faba*, *Phaseolus vulgaris* and *Glycine max* are most salt tolerant than others such as, e.g. *Pisum sativum*. Other legumes like *Prosopis*, *Acacia* and *Medicago sativa* are salt tolerant but their rhizobia are more salt tolerant than the host plants (Zahran *et al.*, 1999). However, selection of acid tolerant rhizobia to inoculate legume hosts under acidic conditions will ensure the establishment of the symbiosis and also successful performance (Correa and Barneix, 1997; Ozawa *et al.*, 1999; Appunu *et al.*, 2005).Recent reports indicated the destructive effects of elevated pH of soils on *Rhizobium*-legume symbiosis and $N_2$ fixation. The number of nodules, $N_2$-ase activity, the nodule ultra structure, and the fresh and dry weights of nodules were affected to a great extend at a low medium pH (<4.5) (Vassileva, 199

In acidic soils with pH of >5.0, where heavy metal activity is relevant, the presence of available aluminum inhibits nodulation (Bordeleau and Prevost, 1994). Rhizobia showed varied responses to aluminum toxicity in acidic soils and cultures. Strains of *Bradyrhizobium* that were resistant of aluminum (200μM) at low pH (4.5) were identified (Ozawa *et al.*, 1999; Appunu *et al.*, (2005). Johnson and Wood (1990) reported that Al was taken up and bound to DNA of both sensitive and tolerance strains but the DNA synthesis by the tolerance strains of *Rhizobium loti* was not affected. However, Richardson *et al.* (1988) found that 7.5 μM Al depressed *nod* gene expression at low pH (4.8).

Legume species vary markedly in their tolerance to $Al^{3+}$ and $Mn^{2+}$, with some plants being significantly more strongly affected by these ions than the rhizobia (Graham, 1992). Therefore, for acid soils with high Al content, improvement is achieved by manipulating the plant rather than the rhizobia (Taylor *et al.*, 1991). Availability of $Ca^{2+}$ in acidic soils with high Al content appears very important for nodulation a low $Ca^{2+}$ conc. (0.13mM) at pH 4.5 greatly affected nodule number, $N_2$-ase activity, and nodule ultrastructure of the *Phaseolus* (Vassileva *et al.*, 1997). Salinity affects the survival and distribution of soil and the rhizosphere of plants (Tate,1995); however, salt tolerant rhizobia are isolated from various crop and these rhizobia underwent morphological, metabolic and structural changes, to cope with and adapt to salt stress. The cited reports support the finding that some rhizobia have the potential to form an effective symbiosis with

gumes under edaphic stress conditions. Selection of stress tolerant legume genotypes for the effective *Rhizobium*-legume symbiosis under these conditions is also equally important. Also, recent reports point out that *Bradyrhizobium* formed a successful symbiosis with soybean under acidic (pH 4.5) and alkalinity (pH 8.5). Selection of naturally occurring stress resistant symbiotic bacteria would be great asset for the improved production and productivity of legume crops.

This article recognizes the importance of natural resource (Rhizobia) and their role in BNF as an environment friendly-non-polluting and more cost-effective way to improve soil fertility compare to other ways. The *Rhizobium*-legume symbiosis is superior to other $N_2$ fixing systems with respect to $N_2$ fixing potential and adaptation to all kinds of severe edaphic conditions. Several symbiotic systems of legumes which are tolerant to extreme conditions of salinity, alkalinity, acidity, drought, fertilizer, metal toxicity, etc., were identified. These associations might have sufficient traits necessary to establish successful growth and $N_2$ fixation under the conditions prevailing in any ecological regions. These symbioses represent the best source of the "ideal" of fertilizer in any agro-ecological regions and therefore command great interest as the subject of future research.

## REFERENCES


Appunu C, Sen D, Dhar B (2005). Acid and aluminium tolerance of *Bradyrhizobium* isolates from traditional soybean growing areas of India. *Indian J. Agric. Sci.* 75(12): 727-728.

Bayoumi HEA, Biro B, Balazsy S, Kecskes M (1995). Effects of some environmental factors on *Rhizobium* and *Bradyrhizobium* strains. *Acta Microbiol. Immunol. Hungr.* 42: 61-69.

Bordeleau LM, Prevost D (1994). Nodulation and nitrogen fixation in extreme environments. *Plant Soil* 161:115-124.

Bottomley P (1991). Ecology of *Rhizobium* and *Bradyrhizobium*. P. 192-347. In Stacey G, Burris RH, Evans H J (Eds.), *Biological nitrogen fixation*. Chapman and Hall, New York.

Brockwell J, Bottomley PJ, Thies JE (1995). Manipulation of rhizobia microflora for improving legume productivity and soil fertility: a critical assessment. *Plant soil* 174: 143-180.

Carter JM, Gardner WK, Gibson AH (1994). Improved growth and yield of faba bean (*Vicia faba* cv. Fiord) by inoculation with strains of *Rhizobium leguminosarum* biovar *viceae* in acid soils in south-west Victoria. *Austr. J. Agric. Res.* 45: 613-623.

Correa OS, Barneix AJ (1997). Cellular mechanisms of pH tolerance in *Rhizobium loti*. World *J. Microbiol. Biotechnol.* 13:153-157.

Freiberg C, Fellay R, Bairoch A, Broughton WJ, Rosenthal A, Perret X (1997). Molecular basis of symbiosis between Rhizobium and legumes. *Nature* 387:394-401.

Gage DJ (2004). Infection and invasion of roots by symbiotic, nitrogen-fixing rhizobia during nodulation of temperate legumes. *Microbiol. Molecular Biol. Rev.* 68(2):280-300.

Graham PH (1992). Stress tolerance in *Rhizobium* and *Bradyrhizobium*, and nodulation under adverse soil conditions. *Can. J. Microbiol.* 38: 475-484.

Graham PH, Draeger K, Ferrey ML, Conroy MJ, Hammer BE, Martinez-Romero E, Naarons SR, Quinto C (1994). Acid pH tolerance in strains of *Rhizobium* and *Bradyrhizobium*, and initial stud-

ies on the basis for acid tolerance of *Rhizobium tropici* UMR1899. *Can. J. Microbiol.* 40: 198-207.

Ibekwe AM, Angle JS, Chaney RL, van Berkum P (1997). Enumeration and nitrogen fixation potential of *Rhizobium leguminosarum* biovar *trifolii* grown in soils with varying pH values and heavy metal concentrations. *Agric. Ecosyst. Environ.* 61: 103-111.

Johnson AC, Wood M (1990). DNA, a possible site of action of aluminium in *Rhizobium* spp. *Appl. Environ. Microbiol.* 56: 3629-3633.

Jordan DC (1984). Family III. *Rhizobiaceae*. In Bergey's manual of systematic bacteriology. Vol.1, Krieg NR and Holt IG (Eds), p.32-242. Williams & Wilkins, Baltimore, Madison.

Kaneko T, Nakamura Y, Sato S, Minamisawa K, Uchiumi T, Sasamoto S, Watanabe A, Idesawa K, Iriguchi M, Matsumoto M, Shimpo S, Tsuruoka H, Wada T, Yamada M, Tabata S (2002). Complete genomic sequence of nitrogen-fixing symbiotic bacterium *Bradyrhizobium japonicum USDA110. DNA Res.* 9: 189-197.

Kulkarni S, Nautiyal CS (2000). Effects of salt and pH stress on temperature-tolerance *Rhizobium* sp. NBRI330 nodulating *Prosopis juliflora*. *Curr. Microbiol.* 40 (4): 221-226.

Mandimba GR (1995). Contribution of nodulated legumes on the growth of *Zea mays* L under various cropping systems. *Symbiosis* 19:213-222.

Meghvanshi MK, Prasad K, Mahna SK (2005). Identification of pH tolerant *Bradyrhizobium japonicum* strains and their symbiotic effectiveness in soybean (*Glycine max* (L.) Merr.) in low nutrient soil. *Afr. J. Biotechnol.* 4(7): 663-666.

Moulin L, Munive A, Dreyfus B, Biovin-Masson C (2001). Nodulation of legumes by members of beta-subclass of Proteobacteria. *Nature* 41: 950.

Mpepereki S, Makonese F, Wollum AG (19 Physiological characterization of indigenous bia nodulating *Vigna unguiculata* in Zimbab soils. *Symbiosis* 22: 275-292.

Nour SM, Cleyet-Marel J, Beck D, Effo Fernandez MP (1994). Genotypic and pheno diversity of *Rhizobium* isolated from chick (*Cicer arietinum* L.). *Can. J. Microbiol.* 345-353.

Ozawa T, Imai Y, Sukiman HI, Karsono H, Adia Saono S (1999). Low pH and aluminium to ance of *Bradyrhizobium* strains isolated from soils in Indonesia. *Soil Sci. Plant Nutri.* 45: 992.

Peoples MB, Herridge DF, Ladha JK (1995). logical nitrogen fixation: an efficient source trogen for sustainable agricultural produc *Plant Soil* 174: 3-28.

Rao DLN, Sharma PC (1995). Effectiveness Rhizobial strains for chick pea under salinity and recovery of nodulation on desalinization. *Indian J. Exp. Biol.* 33: 500-504.

Raza S, Jornsgard B, Abou-Taleb H, Christiansen (2001). Tolerance of *Bradyrhizobium* (*Lupini*) strains to salinity, pH, $CaCO_3$ and biotics. *Lett. Appl. Micribiol.* 32: 379-383.

Richardson AE, Simpson RJ, Djordjevic MA, BJ (1998). Expression of nodulation genes *Rhizobium leguminosarum* biovar *trifolii* fected by low pH and by $Ca^{2+}$ and Al ions. *Environ. Microbiol.* 54: 2541-2548.

Shenbagarathi R (1993). Isolation and characterization of mutants of *Rhizobium* SBS-R100 sym

otic with *Sesbania procubens*. *Soil Biol. Biochem.* 25: 1339-1342.

Tang C, Thomson BD (1996). Effects of solution pH and bicarbonate on the growth and nodulation of a range of grain legumes. *Plant Soil* 186: 321-330.

Tate RL (1995). Soil microbiology (symbiotic nitrogen fixation), p.307-333. John Wiley & Sons, Inc., New York.

Taylor RW, Williams ML, Sistani KR (1991). Nitrogen fixation by soybean-*Bradyrhizobium* combinations under acidity, low pH and high Al stresses. *Plant Soil* 131: 293-300.

Thomas RJ, Askawa NM, Rondon MA, Alarcon HF (1997). Nitrogen fixation by three tropical forage legumes in an acid soil savanna of Colombia. *Soil Biol. Biochem.* 29: 801-808.

Tilak KVBR, Ranganayaki N, Pal KK, De R, Saxena AK, Nautiyal CS, Mittal S, Tripathi AK, Johri BN (2005). Diversity of plant growth and soil health supporting bacteria. *Curr. Sci.* 89(1): 136-150.

Van Rossum D, Muyotcha A, De Hope BM, van Verseveld HW, Stouthamer AH, Boogerd FC (1994). Soil acidity in relation to groundnut-*Bradyrhizobium* symbiotic performance. *Plant Soil* 163: 165-175.

Vargas AAT, Graham PH (1988). *Phaseolus vulgaris* cultivar and *Rhizobium* strain variation in acid-pH tolerance and nodulation under acid conditions. *Field crops Res.* 19: 91-101.

Vargas AAT, Graham PH (1989). Cultivar and pH effects on competition for nodule sites between isolates of *Rhizobium* in beans. *Plant Soil* 117: 195-200

Vassileva V, Milanov G, Ignatov G, Nikolov B (1997). Effect of low pH on nitrogen fixation of common bean grown at various calcium and nitrate levels. *J. Plant Nutri.* 22: 79-294

Vitousek PM, Aber JD, Howarth RW, Likens GE, Matson PA, Schindler DW, Schlesinger WH, Tilman DG (1997). Human alteration of the global nitrogen cycle: sources and consequences. *Ecol. Appl.* 7: 737-750.

Zahran HH (1999). *Rhizobium*-Legume symbiosis and nitrogen fixation under severe conditions and in an arid climate. *Microbiol. Molecular Biol. Rev.* 63(4): 968-989.

Zehr JP, Jenkins BD, Short SM, Steward GF (2003). Nitrogenase gene diversity and microbial community structure: a cross-system comparison *Environ. Microbiol.* 5:539-554.

Journal of Natural Resource & Development 1(1):53-58, 2006



# PLANT PROTECTION STRATEGES FOR THE MANAGEMENT OF SOIL BORNE DESEASES BY USING I.P.M. TECHNOLOGY

**B.K. Goswami, *Rajesh Kumar Pandey and Kabindra Singh Rathour**

*Division of Nematology, *Division of Plant Pathology*

*I.A.R.I., New Delhi-110012*

## ABSTRACT

In the present article an account on plant parasitic nematodes and soil-borne plant pathogenic fungi, which coexist and cause serious diseases of many agricultural crops have been described. The cumulative effect of both fungi and the nematode is reported to cause synergistic effect which is much more damaging than the effect by either of the above disease causing agents. The authors have been engaged to carry out investigations with an intention to protect the crops from the additive effect of the above natural hidden microscopic enemies through ecofriendly means. A technology for the ecofriendly protection has also been proposed through intensive studies both in the laboratory and in the farmer's fields.

**Key words:** Management, crop, disease, nematode and fungi

Nematodes belonging to phylum Nematoda are thread like, microscopic, unsegmented, bilaterally symmetrical and pseudocoelomate organisms. In human beings most common nematode diseases are caused by *Ancylostoma duodenale* causing hookworm desease (Ancylostomiosis), and *Wucheraria bancrofti* causing elephantiasis. Plant parasitic nematodes, are stylet bearing ubiquitous, and cause serious concern to the crops. On the basis of feeding they are classified as: (a) Ectoparasitic (b) semi endoparasitic and (c) Endoparasitic. The endoparasitic nematodes are the matter of concern for the Plant Protectionists as its representative, root-knot nematode that is polyphagous (wide range of hosts) and cause great damage to crops. The infective stage of this endoparasitic nematode is 2nd stage larvae which after undergoing moults inside the host roots develops into adult female bearing egg masses which are exposed to soil.

In nature, both the plant parasitic nematode e.g. root knot and phytopathogenic fungi cause serious loss to a large number of crops. Among the pathogenic fungi mostly soil-borne wilt causing, root- rot causing and damping off fungi are noteworthy as candidates for causing disease complexes with root-knot nematode. There are numerous reports of disease complexes in various crops in which nematodes have been known to predispose the host for fungal attack and thus considered as 'primary pathogen.' As most of the disease complexes cause synergistic effect on the host, a considerably high loss in yield is encountered alongwith adverse effect on the ecosystem. Atkinson (1892) was first to report disease complex in cotton by Root Knot Nematode, *Meloidogyne incognita* and wilt fungus, *Fusarium oxysporum* causing synergistic effect. Powell *et. al.*, (1971) showed that roots of mature tobacco plants infected by *M. incognita* were predisposed to *Pythium ultimum* and *R. solani*. Golden and Van Gundy (1975) showed that galled roots of field grown okra, an tomato infected with *M. incognita* were more susceptible to infection by *R. solani* than non galled roots on the same plant. Several papers published from IARI, New Delhi also showed that *M. incognita* predisposed the host for fungal attack resulting in more damage or synergistic effect. Powell 1971 has rightly recognized nematodes as primary pathogens while fungi or bacteria as secondary pathogen in synergistic relationship with most of the studies on interaction made in the past confirming this categorization.

In most of the cases, management of nematodes (being the primary pathogen) of an interaction is fundamental to manage the disease complex, which would evidently minimize the incidence of disease complex. This prompted the plant pathologist to attempt for the

management of the diseases through eco-friendly methods.

**Bio-management of diseases and disease complexes :** The pesticides now available lack several of the desirable qualities and are phytotoxic and harmful to natural enemies, animals and the environment. This prompted plant pathologists and nematologist to investigate some alternate eco-friendly methods for the management of the root-knot nematode and/or soil-borne fungi. The disease complex incidences caused by root-knot nematodes and soil-borne fungi were also reduced to a great extent by virtue of management of root-knot nematode, which is established as "Primary Pathogen" thus restricting the predisposing factor for the pathogenic fungal attack. Prior to management of root-knot nematode through fungal bioagents, which is presently in fore front, some investigations on management of root-knot nematode through non-chemical methods have been enumerated below:

**(A) Botanical antagonists:** Ever since Linford *et.al.*, (1938) observed reduced galling on incorporating chopped cabbage leaves into root-knot infested soil a long list of many weeds and neglected plants like *Andrographis paniculata, Argemone mexicana, Azadirachta indica, Calotropis gigantean, Datura metel, Eclipta alba, Eichhornea hispeda, Phyllanthus niruri* etc have been reported to possess nematicidal properties (Egumjobi and Afolami, 1976; Goswami and Vijayalakshmi, 1986; Sharma and Trivedi, 1994)

**(B) Oil-seed cakes** of Castor (*Ricinus communis*), Mahua (*Madhuca Indica*), Mustard (*Brassica campestris*), Neem (*Azadirachta indica*), Karanj (*Pongamia glabra*), Undi (*Calophyllum inophyllum*) etc have been widely used for management of root-knot nematode infecting vegetables and pulses (Goswami and Swarup, 1971; Khan *et. al.*, 1979) and also soil-borne fungi viz., wilt, root rot etc. (Sharma and Bedi, 1980; Sen and Chakravarti). Combinations of oil-seed cakes and nematicides in reduced dose have also been demonstrated to perform better when either of them used alone in reducing nematode population with improvement in plant health. (Bhattacharya & Goswami, 1987; Goswami & Mishra 1994)

**(C) Fungal bioagents** with the first report of a fungus, *Harposporium anguillulae* for the control of sugar beet nematode *Heterodera schachtii* by Lohde in 1874 from Germany some sporadic reports of nematophagous fungi from 1940 till 1980 appeared from Europe and USA on this aspect. The nematophagous fungi are conveniently classified as:

**(a). Predaceous or trapping fungi** which capture nematodes by various devices such as sticky branches (*Dactylella lobata*), constrictings rings (*Dactylaria candida*) etc.

**(b). Endozoic or endoparasites**, which produce either simple of, flagellate spores as infectious agents. Spores are ingested in nematodes and reach oesophagal / buccal cavity where they germinate and colonise body cavity etc. *Meria coniospora, Catenaria anguillulae* etc. However, with the obligate nature of these two categories causing difficulty in mass production and ecological sensitivity. They are seldom recommended as biocontrol agents for commercialization. In recent years attention is, therefore, concentrated on:

Toxic and egg parasitic or opportunistic fungi of saprophytic nature, which are commercially viable and easily culturable on artificial media mostly constituting the soil fungi which either, produce toxin and/or colonize the reproductive structure of nematodes. The latter particularly attack *Meloidogyne; Heterodera* and *Globodera* species whose sedentary stages are most vulnerable to invasion while the former types mainly kill the infective 2nd stage larvae of same nematode. The toxic fungi are mainly represented by the species of *Aspergillus* while the examples of egg parasitic or opportunistic fungi are *Paecilomyces, Cladosporium, Trichoderma* and *Verticillium.*

**(d) VA-Mycorrhiza:** Another friendly endoparasitic fungal bioagents Vesicular Arbuscular Mycorrhiza (VAM) represented by the genus *Glomus*, in recent years has been proved to be very useful in the management of fungal, nematode and disease complexes caused by both (Jalali & Thareja, 1981; Singh *et.al.* 1990). *Glomus fasciculatum* and *G.etunicatum* expressed an ideal management component along with karanj and mustard oilseed cake for *M.incognita* in brinjal and tomato, respectively (Singh & Goswami 2001 and Bhagwati & Goswami (2000).

An extensive survey during 1995-97 of root knot affected vegetables around the country showed consistent association of some fungal bioagents viz. as presented in Table-1 from egg masses of *M.incognita*.

**Table-1**. Fungi isolated from egg mass of root-knot nematode

| S.No. | Fungal Geners | Number of species | Number of isolates |
|---|---|---|---|
| 1 | *Acremonium* | 1 | 2 |
| 2 | *Aspergillus* | 7 | 17 |
| 3 | *Cladosporium* | 1 | 3 |
| 4 | *Chetomium* | 1 | 1 |
| 5 | *Geotrichum* | 1 | 1 |
| 6 | *Paecilomyces* | 2 | 7 |
| 7 | *Penecillium* | 1 | 2 |
| 8 | *Sepedonium* | 1 | 1 |
| 9 | *Trichoderma* | 2 | 3 |
| Total | | 17 | 37 |

Sources: Project report submitted to DBT 1998 by Dr. B. K. Goswami

**Tests of isolated fungal bioagents against root-knot nematode and pathogenic fungi:**

Some consistently occurring fungi from root knot affected vegetables were separately isolated both in potato dextrose broth and potato dextrose agar for categorization of toxic and egg parasitic fungi by the authors respectively. The same fungi were also tested against some pathogenic fungi for their mycotoxic nature.

The larvicidal test: Table-2 clearly showed high toxic properties of *Aspergillus* species which totally killed second stage juveniles of *M. incognita* after 48 hrs while *Trichoderma* exhibited mild toxicity with 48% mortality after 48 hrs. The pathogenic fungus *Rhizoctonia* showed least toxic effect on *M.incognita* larvae.

**Table-2.** Effect of culture filtrate of different fungi on mortality of *M.incognita* juveniles after 24, 48 and 72 hrs.

| S.No. | Fungi | Mortality (%) after | | |
|---|---|---|---|---|
| | | 24 hrs | 48 hrs | 72 hrs |
| 1 | *A..niger* | 60 | 75 | 100 |
| 2 | *A..terreus* | 68 | 78 | 100 |
| 3 | *F.oxysporum* | 20 | 38 | 42 |
| 4 | *R.solani* | 14 | 27 | 36 |
| 5 | *T.viride* | 54 | 65 | 80 |
| 6 | *P.lilacinus* | 38 | 48 | 60 |
| 7 | Control (W) | 2 | 3 | 5 |

Sources: Project report submitted to DBT 1998 by Dr. B. K. Goswami

The above results of toxic properties of *Aspergillus* spp was confirmed by hatching inhibition test (Table-3) where fresh egg masses of *M. incognita* were allowed to hatch after being exposed through soaking in each of the above fungal filtrates (isolated from egg masses for 36 hrs) separately. Here the number of larvae hatched were least in most toxic fungal filtrate i.e. *Aspergillus* while maximum hatching was recorded in the filtrate which were least toxic.

**Table-3.** Effect of hatching on *M. incognita* eggs after exposing egg-masses to different fungal filtrates.

| S.No. | Fungi | 24 hrs | 48 hrs | 72 hrs | Total |
|---|---|---|---|---|---|
| 1 | *A..niger* | 24 | 22 | 21 | 67 |
| 2 | *A..terreus* | 20 | 18 | 23 | 61 |
| 3 | *F.oxysporum* | 82 | 55 | 45 | 192 |
| 4 | *R.solani* | 96 | 48 | 77 | 221 |
| 5 | *T.viride* | 80 | 38 | 39 | 157 |
| 6 | *P.lilacinus* | 50 | 58 | 60 | 168 |
| 7 | Control (W) | 128 | 162 | 105 | 395 |

Sources: Project report submitted to DBT 1998 by Dr. B. K. Goswami

To all the above fungi grown separately on PDA for 10 days in BOD incubator at 25±2 °C fresh egg masses after surface sterilization in 0.01 % Hg Cl2 was kept. The percentage of egg parasitiz of *M. incognita* by each of the isolated fungus (Table-4) as observed under binocular after staining with cotton blue lactophenol showed 70 % and 60 % in *P. lilacinus* and *T.viride*, respectively.

**Table-4 Egg parasitizing efficiency of different fungi isolated from egg masses of *M.incognita*.**

| S.No. | Fungi | % egg parsitized | Colonization of matrix |
|---|---|---|---|
| 1 | *A..niger* | 00 | + |
| 2 | *A..terreus* | 00 | + |
| 3 | *F.oxysporum* | 32 | + |
| 4 | *R.solani* | 20 | + |
| 5 | *T.viride* | 60 | + |
| 6 | *P.lilacinus* | 70 | + |
| | C.D.@5% | 3.8 | – |

Sources: Project report submitted to DBT 1998 by Dr. B. K. Goswami

Interaction between fungal bioagents and pathogenic fungi: An interaction study between the fungal

bioagents *A. niger*, *A.terreus*, *P.lilacinus* and *T. harzianum* against *F. oxysporum* f. sp. *lycopersici* and *R. bataticola* expressed overpowering of both the pathogenic fungi. On confirmation of two types of fungal bioagents, attempts were made to investigate the effect of the dual application of both under glass house condition which plant growth improved. Goswami and Singh, (2001) established that *A. niger* (toxic) and *C. oxysporum* (egg parasitic) when applied in reduced dose performed better in improving the vigour of eggplant with suppressed *M. incognita* population (Table –5).

fungi for both directly seeded (pulse and other crops) and transplantable (tomato, brinjal etc.) crops. The treatment proved promising results for the management of diseases caused by soil-borne fungi (wilt, root-rot) and root-knot nematodes in many crops. The disease complex incidences caused by root-knot nematodes and soil-borne fungi were also reduced to a great extent by virtue of management of root-knot nematode, which is established as "Primary Pathogen

**Table-5** Effect of *Aspergillus niger* and *Cladosporium oxysporum* singly and in combination on plant growth and nematode multiplication on eggplant.

| Treatment | Sh. ht (cm) | No. of galls per plant | No.of eggmass per plant | No.of egg per eggmass | Nematode population (250 ml) |
|---|---|---|---|---|---|
| UC | | 23.4 | 0.0 | 0.0 | 0.0 |
| Nematode (alone) | 15.5 | 84 (9.1) | 71.3 (8.4) | 160.6 (12.6) | 2577 (50.7) |
| An+N | 19.6 | 53 (7.3) | 31.6 (5.6) | 112 (10.5) | 238 (15.4) |
| Co+N | 18.6 | 36.6 (6.0) | 19.6 (4.4) | 6 (7.5) | 1213 (34.7) |
| An+Co | 21.7 | 16.6 (4.2) | 13.6 (3.7) | 42 (4.6) | 157 (12.5) |
| CD at 0.05 | 1.2 | 0.7 | 0.5 | 1.0 | 1.5 |

Values presented in parentheses are square root transformed values @ (√x+0.5)
Sources: Project report submitted to DBT 1998 by Dr. B. K. Goswami

The mode of action of dual application of combined effect of both toxic (e.g., *A. niger*) and an egg parasitic (*P. lilacinus*) was attributed to reduction of a reasonable number of infective 2nd stage juvenile occurring in soil around the root zones by toxic fungus. Out of the remaining reduced number of juveniles invaded in the roots, they will be attacked by *P. lilacinus* resulting in production of unviable and empty eggs. Further, it is also established that the oil-seed cakes possess both nematicidal and fungicidal properties. They have also been demonstrated to aggravate several saprophytic fungi including *Aspergillus, Trichoderma* etc, which are fungal bioagents against both, pathogenic fungi and plant parasitic nematodes. It was, therefore, felt desirable to combine oil-seed cakes with two fungal bioagents (one toxic and the other egg parasitic). Thus the treatment with combinations of neem oil seed cake and two fungal bioagents in reduced dose (in talc based formulation) was attempted in fields highly infested with both root-knot nematode and soil-borne

"thus restricting the predisposing factor for the pathogenic fungal attack.

In addition, oil-seed cake which was first reported to enhance the proliferation of the spores of VA mycorrhiza , *Glomus fasciculatum* by Lingaraju and Goswami(1995) and thereafter Bhagawati *et al* (2000) successfully used both neem and mustard oil-seed cakes with VAM fungus. Through the above contribution VA Mycorrhiza was proposed to be an important component of ecofriendly management of soil-borne diseases along with oil-seed cakes. The use of VAM, oil-seed cakes and /or fungal bioagents as an ideal integrated management programe against soil-borne diseases have been demonstrated by Devi and Goswami (1992) and Bhagawati *et al.*,(2000), against *M. incognita* infecting Cowpea, and tomato respectively.

On confirmation of better performance of dual application under glass house condition talc based bioformulations were successfully prepared for the field

evaluation.

In an attempt for the management of *M. incognita* and soil borne (root-rot and wilt) fungi in both directly seeded (chickpea) and transplantable (tomato) crop in heavily infested farmers field for two successive years, the integrated approach with oilseed cake and fungal bioagents (in talc based formulations have responded most promising results. Out of few combinations tried, neem cake +combined effect of *T. viride* and *P. lilacinus* (in reduced dose) suppresses *M. incognita* population below minimum threshold level with excellent plant vigor.

A Proposed Technology: On the basis of extensive investigations both under lab and field authors thus proposed by integrating a toxic and an egg parasitic fungal bioagents (in reduced dose), with oil seed cakes and also VA Mycorrhiza, separately for both directly seeded and transplantable crops. In case of the former the treatment is to be applied along with sowing of seeds while for the transplantable crops it is to be done in 3 phases viz.,

(a) At nursery bed,

(b) Root-dip treatment prior to transplantation and

(c) Spot treatment of the bioagents.

The out standing performance of this integrated treatment is attributed to the combined effect of the toxic and egg parasitic fungus for maximum reduction of *M. incognita* population, which also minimized the disease complex incidence. The neem cake and also *T. viride* showing fungicidal properties, reduces the damage due to fungal attack in addition *T. viride* has also been known to contain the growth hormone.

The above promising treatments proposed by several multi-locational trials in different agro climatic regions of the country on different crops against root-knot nematode, soil borne fungi and disease complexes caused by both prior to recommendation to our farmers.

**REFERENCES:**


Atkinson, G. F. (1892). Some diseases of cotton. Bull. No. 41 *Albama Polytechnical Instt. Expt., Sta*.,64-65.

Bhagawati, B. and Goswami, B. K. (2000). Interrelationships between *Meloidogyne incognita* and *Fusarum oxysporum* f. sp.*lycopersici* on tomato. *Indian J. Nematol.* 30(1): 93-94.

Bhagawati, B., Goswami, B. K. and C. S. Singh (2000). Management of disease complex of tomato caused by *Meloidogyne incognita* and *Fusarium oxysporum* f.sp. *lycopersici* through bioagents. *Indian J. Nematol.* 30 (1): 16-22.

Bhattacharya, D and Goswami, B. K. (1987) Comparative efficacy of neem and groundnut oil-seed cake with aldicarb against *Meloidogyne incognita* in tomato..*Revue de Nematol.* 10 (4): 467-470.

Desai, M.V.,Shah, H. M. and Pillai, S. M. (1972). Effect of *Aspergillus niger* on root-knot nematode, *Meloidogyne incognita*. *Indian J. Nematol*.2: 210-214.

Devi, Pramila and Goswami, B. K. (1992). Effect of VA mycorrhiza, *Glomus fasciculatum* on disease incidence due to caused by the interaction of *Meloidogyne incognita* and *Macrophomina phaseolina* on cowpea. *Annals of Agric. Res.* 13(3): 253-256.

Egunjolei, O. A. and Afolami, S. O. (1992). Effect of neem leaf extract on populations of *Pratylenchuss brachyurus* and on the growth and yield of maize. *Nematologica*. 22: 125-132.

Golden, J. K. and Vangundy S. D. (1975). Disease complex of okra and tomato involving the nematode, *Meloidogyne incognita* and the soil inhabiting fungus *Rhizoctonia solani*. *Phytopathology* 65:265-273.

Goswami B. K. and Vijayalakshmi, K. (1986). Efficacy of some indigenous plant materials and non-edible oil-seed cakes against *Meloidogyne incognita* on tomato. *Ind. J. Nematol.* 16(2) : 280-281.

Goswami, B. K. and Satyendra Singh (2002). Effect of *Aspergillus niger* and *Cladosporium oxysporum* on root-knot nematode (*Meloidogyne incognita*) multiplication on egg plant. *Indian J. Nematol* 32 (1): 98-101.

Goswami, B.K.; Pandey, Rajesh Kumar; Bhattacharya, Chaitali and Lokendra Singh (2005). Evaluation of six isolates of *Trichoderma harzianum* against *Fusarium oxysporum* f. sp. *lycopersici* and *Meloidogyne incognita*. *International J. of Namatol* 15 (1): 83-86.

Goswami, B. K. and Mishra, S. D. (1994). Comparative efficacy of neem cake and carbofuran on plant parasitic nematodes infecting pea.

*Curr. Nematol.* 3(1): 7-12.

Goswami, B. K. and Swarup, G. (1971). Effect of oil-seed cake amended soil on the growth of tomato and root-knot nematode population. *Indian Phytopath.* 24 (3): 491-494.

Jalali, B.L. and Thareja,M.L. (1981). Separation of *Fusarium* wilt of chickpea in Vesicular Arbuscular Mycorrhizal inoculated soil.Intl.*Chickpea Newsl.* 4 : 21-22.

Khan, M.W, Alam M.M and Ahmad, R (1979). Mechanism of the control of plant parasitic nematodes as a result of application of the oil seed cakes to the soil. Indian J. Nematol. 9 : 93-96.

Linford, M.B.; Tapp, B.; and Oilveira, J.M. (1938). Reduction of soil population of root-knot nematode during decoposition of organic matter. *Soil Scince.* 45:127-141.

Lingaraju, S. and Goswami, B.K. (1995). Studies on the effect of neem and mustard oil-seed cakes on cowpea in *Glomus fasciculatum, Rotylenchulus reniformis* interaction. *Indian J. Nematol.* 25(1): 33-37.

Lohde, G (1874). Einige neuen parasitischen Pilze. Tageblatz. . 47: 203-206.

Pandey, Rajesh Kumar; Goswami, B. K.; Singh, S. (2005). Management of root knot nematode and *Fusarium* wilt disease complex by fungal bioagents, neem oilseed cake and/or VA-Mycorrhiza on chickpea. *International Newsletters of Chickpea and Pigeonpea, ICRISAT,* 12: 32-34. *and Pigeonpea, ICRISAT,* 12: 32-34.

Pandey, Rajesh Kumar; Goswami, B. K. (2009). *cillus subtilis*: An Ecofriendly Effective Bacterial tagonist of *Fusarium udum* Butler Causing Wilt ease of Pigeonpea (*Cajanus cajan* Millsp). *The ceedings of the National Academy of Scienc Section B-Biological Sciences* 75 (IV): 234-237

Pandey Rajesh Kumar, Chaitali Bhattacharya, B Goswami and Lokendra Singh (2006). Manage of root knot nematode infecting brinjal through co bination of fungal bioagents, *Aspergillus fumigat* and *Trichoderma harzianum*. *Indian J. of Pla pathology* 59 (2) 177-179.

Powell, N.T. (1971). Interaction between nematod fungi in disease complexes. Ann. Rev. Phytopat 9:253-274.

Sharma, J.R. and Bedi, P.S. (1988). Effect of s amendment with oil-seed cakes on wilt of cotton *Res PAU.* 25: 414-416.

Singh, S. and Goswami, B.K. (2001). Interrelatio ships between *Meloidogyne incognita* and *Fusari oxysporum* on susceptible and resistant cultivars cowpea. *Indian J. Nematol.* 31(2):139-142.

Singh, Y. P, Singh, R.S., and Sitaramaiah, K. (19 Mechanism of resistance of mycorrhizal tomato agai root-knot nematode. In *Current Trnds in Myco rhizal Research,* (eds. B.L.Jalali and H.Chand), 9 97, HAU, Hissar..

Zuckermann, B.M., Mathny, M and N. Acos (1994). Control of plant parasitic nematode by a n maticidal strain of *Aspergillus niger*. *J. of Chemi Ecology* 20 : 33-43.

Journal of Natural Resource & Development 1(1):59-64, 2006

# RELEVANCE OF INTELLECTUAL PROPERTY AND BREEDER'S RIGHTS IN AGRICULTURE

**B. Sinha, C.V.C.M. Reddy and A.V.V. Reddy***
*Banaras Hindu University, Varanasi - 221 005 (U.P.)*
**Directorate of Oil Seeds Research, Hyderabad (A.P.)*

**Dunkel's draft and issue of intellectual property rights on living forms under world trade Organization (WTO)**

Under the agreed text, Article 27.3 (b) exclusively deals with the protection aspects of plants and provides the option for exclusion in the Trade Related Intellectual Property Rights (TPIPS) from patentability. It is mentioned that countries may exclude from patentability "plants animals other than microorganisms, and essentially biological processes for the production of plants or animals other than non-biological and microbiological processes. However, PARTIES shall provide for the protection of plant varieties either by patents or by an effective *sui generic* system or by any combination thereof. This provision shall be reviewed four years after the entry into force of this agreement."

In other words, some form of an Intellectual Property Right on Plants has to be had. In this behaviour, it is worthwhile to understand the system *per se*. In literal meaning sui generic means a system of its ownkind. Thus, it is clear that the countries have freedom and flexibility in devising a system of their own for the protection of new varieties of plants, keeping the best national interest in view. However, the form of protection has to be effective and its effectiveness is subject to review.

## THE ISSUE OF SEED AND INTELLECTUAL PROPERTY RIGHTS IN PLANTS

Realizing that quality seed and/ or planting materials are basic to agriculture, essential for enhancing productivity, production and income of farmers, and necessary for ensuring other production inputs to be productive and cost effective, the availability of quality seeds and/ or planting materials to meet specific needs of the farmers in changing agricultural scenario remains crucial for the success of agriculture.

A group of nations are already following a system of protection and this International Union for the Protection of New varieties of Plants is commonly known as "UPOV". Its origin lies in the abbreviation based on the initials in French-Union pour la Protection does Obtentions Vegetables.

The union, as on March 31, 1996, comprises 30 member countries, namely, Argentina, Austria, Belgium, Canada, Chile, Czech Republic, Denmark, Finland, France, Germany, Hungry, Ireland, Israel, Italy Japan, The Netherlands, New Zealand, Norway, Poland, Portugal, Slovakia, South Africa, Spain, Sweden, Switzerland, Ukraine, United Kingdom, United States of America and Uruguay.. All are party to its 1978 Act of UPOV, with the exception of Belgium and Spain, which are to its 1961 Act as amended by its additional Act of 1972. However, countries like Belgium, Canada, Denmark, France, Germany, Ireland, Israel, Italy, The Netherlands, New Zealand, South Africa, Spain, Sweden, Switzerland, the United Kingdom, and the United States of America have agreed to be the party of 1991 Convention but the 1991 Act is yet to come in operation as it is not yet ratified by an effective legislation of required number of countries i. e. five states to accede to it, of which at least three must be states which party to the 1987 or earlier Acts of the Convention. As on April 26.1996, only country i.e. Denmark has deposited the instrument of accession to 1991 convention.

Any non-member state is given the options to accede to the 1978 Act at any time until the 1991 Act comes into force. Thereafter, the 1978 act will be closed further accession

Various provisions and comparison on major counts viz. Membership, scope, period of protection, number of genera/species required to be protected, kind of restriction and treatment etc. of two (1978

and 19991) Act are presented in Table 1. Essentially, 1991 Act is in favour of breeder/industry as compared to 1978 Act. This was considered appropriate particularly in developed world whereas 1978 is being felt appropriate for developing countries where many more exemption in favour of farmers is considered essential. At times, misunderstanding does occur when patent provisions are not differentiated from plant variety protection. A comparison of the two as in Table 2 clearly indicates how vastly they do differ in scope, condition of protection, use of variety/ material, etc.

**Title Enforcement status on New varieties of Plant :**

Form the world wide developments, it is amply evident that Intellectual Property Protection in Plant in the near future, no longer be the domain of only the developed world. In the implementation of a system of protection of Intellectual Property Rights in plant, it is imperative that prevailing systems in the developed countries are under stood properly. Based on the understanding, system best suited to individual developing nations are put in place with appropriate structural adjustments. In this context, it would be most appropriate to have an idea of the implements associated with this activity in different countries. During the period 1990-1994, title of protection issued, ceased and in force for residents and non-residents are presented in Table-3.

In 1994, 35, 146 titles were in force which increased by about 9,00 during a span of four years. The number of titles issued to non –residents during this period was also quite close to those of residents. The total number of titles ceased to exist during this period is also presented in Table-3.

Among countries, maximum activity in this regard was in the Netherlands followed by Germany, France, and Japan. The percentage of titles ceased was maximum is Switzerland, Belgium and Ireland. Although the overall activity in these countries was comparatively much less. Significantly, in the case of United States of America, the activity is much more for grant of patents rather than for grant of plant variety protection titles which obviously the availability of patented materials for further research, which means an uncomfortable situation for the new countries considering the implementation of plant varieties protection regimes.

Before introduction of a system of Intellectual Property Rights in plants in the new opting nations, it is also necessary to have an understanding abut the activities in this direction of these countries that are likely to take maximum interest in the new opting nations. In this context, an attempt is made to understand the interest taken by non-residents for getting plant variety protection titles in different countries. Maximum applications filed for issue of plant variety protection titles by non-residents was again in countries like the Netherlands, Germany, France, the United Kingdom etc. in that order Again, the titles actually issued on non-residents were also maximum in the Netherlands, Germany, the United Kingdom, France etc. In that order. In the United States of America, interest taken by non-residents is obviously much more for getting the grant of patens rather than grant of plant variety.

**Indian Patent Act and Proposed *sui generic* System**

In appreciation of the Intellectual Property Rights in India, legislation was enacted and Indian Patent Act 1970 came into being. Under the Indian Patent Act, "a method of agriculture of horticulture is excluded as pre Section 3 (h)." What does it mean? What would be its logical, legal and technical interpretation? Does it mean that the method of Irrigation or fertilizer application would be not patentable. Legally and technically yes? But it really does not serve any purpose. Further, we take the shelter of article 3(i) which reads as follows " Any process for the medicinal, surgical, curative, prophylactic or other treatment of human beings or any process for a similar treatment of animals or plants to render them free of disease or to increase their economic value or that of their products" is not patentable. Under this, anything on logical interpretation could be excluded and hence the varieties and their seeds, as they can affect the national tremendously are not a patentable subject.

Keeping the situation in totality, well before the GATT negotiations, the issue for developing a system of our own was deliberated where the Indian Council of Agricultural Research took the leading role

It was felt that a Plant Breeders right would be in the best national interest with effective safeguards on farmers access to produce, use, reuse and exchange of their farm produce, breeders access to material for further research, safeguards on germplasm etc. Accordingly, under the new seed policy of 1988, limited protection was granted in practical shape where it was agreed to keep the parental lines of hybrids under triple lock system of importer, D.A.C. and I.C.A.R. so that these materials could not be exploited for commercial ends.

**Likely Scenario on Varietal Development and Seed Fronts**

Investment of Private sector in research and development efforts is expected to increase. Depending on the essential elements of a *sui generic* system, quantum of investments would be determined. If farmers would have complete freedom and flexibility to use, reuse and sell the seeds the way they choose, private sector's thrust on self-pollinated crops would be less as compared to hybrid research and development. Further, the private sector would be much more interested in high value, low volume seeds. They are also likely to be much more interested in high value, low volume seeds. They are also likely to be much more interested where investment is likely to be highly rewarding such as hybrids and obviously the ideal areas and selected crops would be receiving greater attention and investment in future.

Depending on the likely access to external markets, some of the Indian companies would find it worthwhile to have their networks in tropical and sub-tropical regions in the first instance due to better adaptability of their likely technology and would enter in competition in other parts of the world in the second phase. Today, the Indian National Agricultural Research System (N.A.R.S.) is one of the largest in the word. It has 49 Research Institutes, 31 National Research Centres, 10 Project Directorates, 78 All-India Coordinated Research Projects/Networks and 16 other projects/programmes. In agricultural and extension education together, inclusive of one Academy, we have 10 Institutes/National Centres/Programmes. Thus, the I.C.A.R. has 194 research establishments directly under its control. In addition, there are 28 State Agricultural University and one Central Agricultural University under the I.C.A.R. in the Northeastern Hills Complex. In seed sector, where, about 500 small and big companies, 24 of them with links to multinational companies are now functioning with their research and/or development establishments.

On the development side, there exists a National Seed Corporation, established in 1963 and State Farms Corporation of India since 1969 at the central level to organize and undertake foundation and certified seed production besides taking programmes on breeder's seed production on a small scale. At the state level, there are seed corporations in 13 states to organize foundation and certified seed production. Besides, private seed companies are also involved in the production and supply of seeds of public-bred varieties in addition to the seeds of their own varieties.

The public sector may concentrate more to fulfil its public obligations in those areas rather more where private sector investments are likely to be limited. Obviously, drought-prone, salt-affected, coastal, hilly regions etc. would have to be substantially catered by the public sector varietal improvement programmes. Public sector in a vast country like ours would have to play a major role in favourable area as well to provide a healthy competition.

Granting of reciprocal rights would provide a unique opportunity to Indian seed industry to have access to market at the global level. Based on the strength of availability of varieties, vast germplasm resources, highly trained scientific and technical manpower, diversified agro-climatic conditions befitting various crops and commodities in different regions, cheap labour etc. would provide Indian seed industry an edge. However, the fruits of such an access can only be harnessed if the Indian seed industry develops its networks, initially in the tropical and sub-tropical regions and subsequently in other parts of the world. This is absolutely essential to ensure evaluation and establishment of adaptability of Indian varieties before their seed production and its marketing on a large scale is contemplated. Firm commitment with suitable policy initiatives including custom production of seed for 100 per cent export purposes would be vital so that depending on needs, firm production programmes, capi-

talizing on the ground realities, are undertaken and export commitments on a sustainable basis are fulfilled to have continued market access.

Strict policy regulation including quarantine measures with special emphasis on seed borne diseases and viruses would be of paramount significance. Besides, support services from the public sector, private sector would have to have its own quality control system commensurate with the international requirements. In this endeavour, ISTA regulations would be of considerable help to ensure seed marketing on an uninterrupted basis.

To capitalize on the wealth and strength of public sector research efforts, a system would be required in place where production and marketing of public-bred varieties are assured. There would be many options in this endeavour in which public sector institutions would have a tie-up with effective marketing strategies individually or collectively with or without public and private sector agencies.

Based on the deliberations which are taking place at different levels, it is clearly emerging that India should go for a *sui generic* system commensurate with the UPOV 1978 provisions keeping the following five points in the centre :

1. Protection of farmers rights.
2. Exemption of scientists for research use.
3. Protection of extant varieties.
4. Compulsory licensing in the public interest.
5. Deposition of sample in the national genebank.

## Some of the New Initiatives by Institutions and Scientific Organizations Required

Once harnessing the potential under likely new regime, a number of new initiatives will have to be taken by the research institutions and universities. Some key issues needing urgent attention are as follows :

1. Methodologies and procedures for capture and formal documentation.
2. Effective mechanism for DUS testing.
3. Assessment mechanisms for novelty and likely potential economic benefit of protected material.
4. Worldwide P.V.P. search prior to initiative of R&D.
5. Systems for management and marketing of protected varieties.
6. Incentive/reward system for S&T personnel.
7. Building cost of PVO into R&D costs.
8. PVP based information services.
9. Registration system of varieties, hybrids and parental lines of hybrids.
10. R&D linkages especially with private sector.

The Plant Variety Protection in one form or other is a reality at the global level. Hence, instead of deliberating the issue whether to have or not to have P.V.P., we must reorient ourselves to capitalize on our strength and concentrate on weakness so as to overcome them to attain and sustain advantages in the far more likely competitive world. Our energies should go in developing mode, mechanism and system, and establishing synergies to capitalize on out inherent advantages. Although we are categorized as a developing nation but on varietal development front we are highly competitive. Looking to the situation in totality, a *sui generic* system in tune with the 1978 UPOV provisions would be in the overall nation interest. For this, we need to enact a legislation and channelize our energies for developing, testing and registration system for varieties. Similarly, we need to develop a partnership with private sector and bring much needed incentive and reward system in the public sector so that in a vast country like our public sector continues to play its desired role.

**Table 1. Comparison between the two UPOV Acts on Plant Variety Protection**

| Issue | 1978 Act | 1991 Act |
|---|---|---|
| 1 | 2 | 3 |
| 1. Membership | A state can only be the party | Intergovernmental organization competent for enacting and implementation with binding upon on all its member states can also be the party |
| 2. Discovery | Breeder is entitled to protection as 'discoverer' irrespective of the origin, artificial or natural of the initial variation | A mere discovery is not sufficient. The breeder must also have developed the variety |
| 3. National Treatment | Member state may limit the right on a new variety to nationals of states which also apply that act. A similar reciprocity rule may also be applied by a member state granting more extensive rights | Reciprocity rule does apply. Operation of the principle of national treatment to one and all without qualification |
| 4. Scope | Authorization of breeder is required for<br>(i) the production for purposes of commercial marketing of the propagating material<br>(ii) the offering for sale of the propagating material<br>(iii) the marketing of such materials,<br>(iv) the repeated use of the new plant variety for the commercial production of another variety say as parents in case of hybrids<br>(v) the commercial use of ornamental plants or parts thereof as propagating material in the production of ornamental plants or cut flowers<br>(vi) does not require authorization for use of material for further research<br>(vii) Farmers can use/reuse his produce as seed and can dispose of his farm produce. | Authorization of breeder is essential for<br>(i) production or reproduction<br>(ii) conditioning for the purpose of propagation<br>(iii) offering for sale<br>(iv) selling or other marketing<br>(v) exporting<br>(vi) importing and stocking for nay of these purposes.<br>Furthermore, the 1991 Act specifies four subject matters to which the breeder's right extends.<br>(i) the protected variety itself,<br>(ii) varieties which are not clearly distinguished from the protected variety,<br>(iii) varieties which are essentially derived from the protected variety, and<br>(iv) varieties whose production required repeated use of the protected variety. |
| 5. Minimum number of genera or species to be covered | -Atleast 5 to start with<br>-At least 10 within 3 years<br>-Atleast 18 within 6 years<br>-Atleast 24 within 8 years | -UPOV 1978 member states, all after 5 years transitional period<br>-All after 10 years if only bound by 1991 Act. To start 10 with while acceding 15 plant genera/species |

| | | |
|---|---|---|
| 6. Period of protection | -18 years for grapevines and trees including rootstocks<br>-15 years for all other | -25 years<br>-20 years |
| 7. Special Title/ Patent/Protection | Each state is free for any of the two forms of protection except those where it was a practice before October 31, 1979 for providing protection to the same general or species by both | No alternative forms of protection |

**Table 2. A Comparison between Patent Protection and Plant Variety Protection**

| Issue | Patent Protection | Plant Variety Protection |
|---|---|---|
| 1. Object | Invention | Plant variety |
| 2. Documentary examination | Required | Required |
| 3. Field examination | Not required | Required |
| 4. Plant material for testing | Not necessary | Required |
| 5. Conditions for protection | (a) Novelty<br>(b) Industrial applicability<br>(c) Unobviousness<br>(d) An enabling disclosure<br>(e) An appropriate denomination | a. Commercial novelty<br>b. Distinctiveness<br>c. Uniformity<br>d. Stability |
| 6. Determination of scope of protection | Determination by the claims of the patent | Fixed by the nation legislation |
| 7. Use of protected variety for breeding further varieties | May require authorization of the patentee of the right holder (research exemption) | Does not require authorization |
| 8. Use of propagating material of the protected variety grown by a farmer for subsequent planting on the same farm | May require the authority of the patentee | Does not generally require authorization of the right holder |
| 9. Term of protection | Say 30 years | 25 years for trees and vines and 20 years for others (1991, UPOV), 18 years for trees and vines and 15 years for others (1978, UPOV) |

**Table 3. Plant Variety Protection Titles Ceased and Titles in Force for the Residents and Non-residents during 1990-94**

| Year | Application filed by | | | Titles issued to | | | Titles Ceased | Titles in Force |
|---|---|---|---|---|---|---|---|---|
| | Residents | Non-residents | Total | Residents | Non-residents | Total | | |
| 1990 | 4,385 | 3,104 | 7,789 | 2,649 | 1,937 | 4,586 | 2,309 | 26,681 |
| 1991 | 4,436 | 2,902 | 7,338 | 2,570 | 2,010 | 4,580 | 2,748 | 28,527 |
| 1992 | 4,329 | 3,290 | 7,619 | 2,743 | 2,157 | 4,900 | 3,070 | 29,235 |
| 1993 | 4,579 | 3,922 | 8,501 | 3,180 | 2,410 | 5,798 | 3,016 | 31,243 |
| 1994 | 4,795 | 4,078 | 8,883 | 3,606 | 3,606 | 6,990 | 3,357 | 35,146 |

*Source* : UPOV document No. C/2917 of 10 October 1995.

Journal of Natural Resource & Development 1(1):65-67, 2006



# PESTS OF SUGARCANE AND THEIR INTEGRATED MANAGEMENT

**Arvind Nath Singh and P.S. Singh***

*Krishi Vigyan Kendra, P.G. College, Ghazipur-233 001 (U.P.)*

**Department of Entomology, P.G. College, Ghazipur-233 001 (U.P.)*

It is estimated that about 10% of the total sugarcane crop of the country is destroyed evry year due to the attack of different pests. Although, more than 100 species of insects and many non insect pets like mites, nematodes, rats, jackals, squirrels and birds have been recorded on the sugarcane crop as limiting factor but only about 2 dozens species of insect are recommended as major pests for which control measures should be applied.

The pests that generally interacts and damage to the sugarcane crop are given below :

| Name of Pest | Symptoms of damage | Destructive Stage | Month activity |
|---|---|---|---|
| Top borer (*Tryporyza nivella)* | The growing point is killed, top leaf dries up and midrib forms the white streak, which later changes into red colour. Top buds sprouts (bunchy top). | Larvae | February to October |
| Shoot borer (*Chilo infuscatellus*) | Drying of central leaf sheath, when it pooled out gives offensive smell. | Larvae | July to September |
| Stalk borer (*Chilo auricilius*) | Shoot dry up, holes on the stem. | Larvae | March to September |
| Gurudaspur borer (*Acigona steniella*) | Early juvenile stage feeds gregariously and make spiral gallery on the top portion of stem and after dying of plant move on to the adjacent ones. | Larvae | July to October |
| Pink borer (*Sesamia inferens*) | The middle leafs of cane dries. | Larvae | March to September |
| Root borer (*Emmalocera depresella*) | Dead heart with offensive smell, plant can be pulled out easily. | Larvae | April to October |
| Green borer (*Raphimetophus ablutellus*) | The holes the stem just below or at the soil surface are made by the caterpillars. The central whorles of leafs dries-up. | Larvae | July to November |
| Plassey borer (*Chilo tumidicostalis*) | Crown of leafs dry. The frass shined as red out of the whroles in the top internodes. | Larvae | August to September |
| Internode borer (*Chilo indicus*) | Catterpillars make a holes in the internode. | Larvae | August to October |

| Name of Pest | Symptoms of damage | Destructive Stage | Month activity |
|---|---|---|---|
| Pyrilla (*Pyrilla perpusilla*) | Withering of leafs and blackening of leaf surface due to presence of shooty mould. | Nymph and adult | March to October |
| Sugarcane white fly (*Aleurolobius barodensis*) | Withering of leafs and sometime blackening also | Nymph and adult | Almost whole year |
| Spotted fly (*Neomaskella bergii*) | Withering and blackening of leaf | Nymph and adult | Almost whole year |
| Mealy bug (*Pseudococcus sechrifolii*) | Crop looks pale and sickly and cavity like depression on the internodes. | Nymph and adult | Almost whole year |
| Black bug (*Blissus gibbus*) (*Macropes excavatus*) | Crop turns pale and leafs shows deep radish brown spot. | Nymph and adult | March to October |
| Scale insect (*Acanthomytilus sacchari*) (*Odonaspis saccharicaulis*) | Internode is convered with many grayish black scales and may be also on leaf. | Nymph and adult | Almost whole year |
| Sugarcane beetle (*Holotrichia consanguinea*) | Drying of crops due to the attack of grub on root and rootlets | Grub | July to September |
| Army worm (*Pseudaletia unipuncta*) | Leaf is eaten by edges, in serious case, all the green portion is eaten leaving only the midrib. | Larvae | April to June |
| Grasshopper (*Hieroglyphus banian*) (*H. nigrorepletus*) | They eat green tissues of the leaf leaving on midrib | Nymph and adult | Almost whole year |
| Red leaf mites (*Oligonychus indicus*) | The leaf turn radish due to decrease in photo-synthetic activity of leaf. | Nymph and adult | May to June |
| Web mites (*Schizotetranychus andrpogoni*) | The webs are present on leaf, which is whitish in colour, and later on turn brown. The leaf surface shows whitish patches. | Nymph and adult | September to February |
| Rodent (*Rattus meltoda*) (*Mus booduga*) (*Bendicota bengalensis*) | Damage to the underground part of crop. | | Through out year |
| Termites (*Odonotermus obesus*)(*O. assumthi*) | The leaves and stems are cut in irregular triangles. | Grub and adult | Through out year |

Pyrilla (*Pyrilla perpusilla*)
Withering of leafs and blackening of leaf surface due to presence of shooty mould
Nymph and adult March to October

Sugarcane white fly (*Aleurolobius barodensis*)
Withering of leafs and sometime blackening also
Nymph and adult Almost whole year

## Integrated management of sugarcane pests.

The sugarcane is one of the richest source of energy and so is attacked by many of insect pest. It is desirable to have an integrated pest control approach in such a manner that proofs compatible and results in the reduction of pest population as a whole. It is for this reason the control measures are being giving here collectively.

1. Crop sanitation by removing the alternative host plant from the sugarcane field.
2. Selection of healthy sets for sowing.
3. If the problem of borer persists, avoid ratoon cropping.
4. Early planting up to the end of February can check the damage of shoot borer.
5. Clipping of eggs bearing leaf.
6. The infested plant should be removed and burned.
7. The water logging condition particularly in rainy season should be avoided.
8. The egg clusters of *Pyrilla* and top borer can be collected and should be kept in cages so that parasitoids can emerge for further parasitization.
9. Light trap can be used for the collection and distribution of white grub. Similarly the sex pheromone trap can be used for the control of top borer and stalk borer.
10. For control of gurdaspur borer the infested top should be removed per week from July to September.
11. The stripping of dry leaf in month of September may take the care of stalk borer and internode borer.
12. After stripping of dry leaf spraying of 0.1 malathion is helpful in managing the scale insect.
13. Spraying the crop with monocrotophos @ 0.7a.i per hectare after the monsoon shower should be done to check the top borer, *Pyrilla*, white-fly, stalk borer and internode borer.
14. The insecticides like nuvacron, dimecron, dimethoate, systox, metasystox can be used against the sap suckers.
15. For control of termites pre-sowing dipping of sets in solution of fluosilictae or lime and use or crude oil emulsion in water during irrigation at least once in a month.
16. The pre baiting on Ist and IIIrd day and poison baiting on 5th day by zinc phosphide mixed with bajara, groundnut oil is effective to check the rodents.

## Guidelines to Contributors

1. The Journal will publish Research papers, Articles and Communications containing research work as well as reviews from authors.
2. Manuscripts of paper in duplicate should be type written in double space on one side of the bond paper or in CD form.
3. The paper should not have been published or communicated for publication else where. Authors are solely responsible for the factual accuracy of their contribution. The data reported in the paper should not be older than 5 years. Paper should be divided into following sub-heading -
   - (a) **Title** with authors name and address.
   - (b) **Abstract** should indicate the principal findings. It should not be more than 250 words.
   - (c) **Key words :** key words in italics should not exceed 4 or 5 words.
   - (d) **Introduction :** should be brief and without headings. It should relate to the aim of the study.
   - (e) **Materials and methods :** when methods are well known citation of the standard work is sufficient. All measurenents should be in metric units.
   - (f) **Results and Discussion :** The results should be supported by brief and adequate tables, graphs, charts and photographs wherever needed.
   - (g) **Tables and figures :** should be given on seperate papers. Data can be given either in figures or tables but not in both. Figures, illustrations or photographs should be of good quality and suitable for final reduction allowing space for legends.
   - (h) **References :** should be arranged alphabetically without serial numbers as illustrated below :-

**Paper :** Pandey, G.; Pandey, R. and Pant, H., 2003. Efficacy of different levels of *Trichoderma viride* against root-knot nematode in Chickpea (*Cicer aritinum L.*) *Ann. Pl. Protec. Sci.* 11 (1) : 101-104.
Qasim, S.Z. and Gopinathan, C.K. , 1969. Tidal cycle and the environmental features of Cochin back waters (a tropical estuary), *Proc.Indian Acad. Sci.* 698 (6) : 336-48.

**Report :** Pathak, S.C. and Palanisamy, K., 1995. Shrimp and carp aquaculture and the environment in India. *India study report ADB & NACA Publication* : 75 pp. + 45 annex.

**Book :** Pandey, G. and Pant, H., 2003. Jaiv Proodhyogiki : Anusandhan avum Vikas. Published by *Commission for Scientific and Technical Terminology.* New Delhi, 1-182.

**Address for correspondence :**

***Editor,***
*Journal of Natural Resource and Development,*
*Society of Biological Sciences and Rural Development ,*
*10/96, Gola Bazar, New Jhusi, Allahabad-211 019.*
*Phone : (0532) 2568978*

Printed and Published by **Dr. Gopal Pandey**, Society of Biological Sciences and Rural Development, 10/96, Gola Bazar, New Jhusi, Allahabad-211 019 (U.P.), Phone - 0532-2568978
Press Name and Address : **"ANKAN"** *the print people*, 11 Chak Raghunath, Naini, Allahabad. Mob. 9415279696, 9335126694