ISSN - 0974 - 5033

Volume 2, Number 1, February 2007

JOURNAL OF NATURAL RESOURCE AND DEVELOPMENT

Society of Biological Sciences and Rural Development

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

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Journal of Natural Resource and Development 2(1):1-6, 2007

HYPOTHALAMO-NEUROSECRETORY SYSTEM OF THE FRESHWATER CATFISH, *HETEROPNEUSTES FOSSILIS* (BLOCH)

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ABSTRACT

Hypothalamo-neurosecretory system of *Heteropneustes fossilis* comprised mainly of nucleus preopticus (NPO), nucleus lateralis tuberis (NLT) and their axonal tracts. NPO was a paired structure located on either side of the third ventricle slightly above and anterior to optic chiasma. It was highly vascularized structure with broad anterior and narrow posterior ends. NPO was divisible into a dorsal pars magnocellularis (PMC) comprising larger neurosecretory cells and ventral pars parvocellularis (PPC) with smaller neuronal cells. Neurosecretory cells of the nucleus lateralis tuberis (NLT) were distributed in the ventral floor of brain adjacent to the pituitary stalk. Acid fuchsin-positive colloid-like neurosecretory material (NSM) was rarely encountered in NPO and NLT of the catfish. Neurons of PMC and PPC contributed axons to form the neurohypophysial tract.

Key words : Hypothalamus, nucleus preopticus, nucleus lateralis tuberis, Heteropneustes fossilis.

Hypothalamus in the vertebrate brain comprises groups of neurosecretory cells that mediate the organismic endocrine responses and adjustments to the environmental changes through the secretion of varoius trophic hormones of the pituitary by elaborating releasing (-RH) and inhibiting hormones (-IH) (Maksimovich, 1987; Peter *et al.*, 1991). Hypothalamus also contains receptors specifically sensitive to the hormone which, in turn, regulates its activity through feedback mechanism. There are increasing evidences that in fishes too, the hypophysial functions are modulated by the hypothalamic neurohormones but the regulatory mechanisms have not yet been clearly defined (Ball, 1981; Maksimovich, 1987; Peter *et al.*, 1991; Bhattacharya *et al.*, 1994; Subhedar *et al.*, 1999). *Heteropneustes fossilis* has been identified as a candidate species for freshwater aquaculture development in derelict water bodies (Dehadrai and Kamal, 1993). This is an air-breathing fish having high hemoglobin content (11.58%) and can live out of water for several hours if the skin is kept moist (Singh and Hughes, 1995). Therefore, an attempt has been made to record the hypothalamo-neurosecretory system of the freshwater catfish, *Heteropneustes fossilis*.

MATERIALS AND METHODS

30 specimens of *Heteropneustes fossilis* (both sexes; size 16-20 cm; weight 52-68 gm) were collected from pond adjoining Bhubaneswar (Orissa) during November to March. Their brain along with the pituitary and a piece of ovary (to judge the maturity stage) were surgically removed and fixed immediately in freshly prepared Bouin's solution. The tissues were washed throughly in running tap water, dehydrated in ascending series of alcohol, cleared in xylene and embedded in paraffin wax at 60°C. Serial sections (sagittal, frontal and horizontal) were cut at 6-8 µm. Brains and pituitary were stained in Mallory's triple, aldehyde fuchsin (AF) and chrome-alum hematoxylin-phloxine (CAHP) whereas ovaries were stained in hematoxylin-eosin (H&E).

RESULTS

Histological examination of the ovaries revealed the fish to be in spent, I and II stages of maturity (Fig. 1-4). Gonadotrophs of the catfish were confined to the proximal pars distalis (PPD) of the hypophysis. In stage 1, these cells were small in size

and possessed less secretory material (Fig. 5) while they exhibited minor activity as well as accumulation of secretory material in the fishes with ovary in stage 2 of development (Fig. 6). Hypothalamo-neurosecretory system of *Heteropneustes fossilis* comprised mainly of nucleus preopticus (NPO), nucleus lateralis tuberis (NLT) and their axonal tracts. NPO was a paired structure located on either side of the optic chiasma. The broad dorsal end consisted of sparsely distributed neurosecretory cells whereas these cells were closely placed towards the middle and ventral portion (Fig. 7).

The nucleus preopticus (NPO) was divisible into dorsal pars magnocellularis (PMC) consisting of large neurosecretory neuronal cells and ventral pars parvocellularis (PPC) with smaller cells. Thus, a progressive reduction in size of the neurosecretory cells was seen from the dorsal to ventral aspect of NPO. The NPO was a highly vascularized structure and its neurosecretory cells were positive to aldehyde fuchsin (AF), chrome-alum-hematoxylin-phloxine (CAHP) and acid fuchsin (in Mallory's triple stain) (Fig. 7). Acid fuchsin-positive globule-like neurosecretory material was rarely seen in PMC and PPC. Most of the PMC and PPC neurosecretory cells were bipolar and contributed axons to form neurohypophysial tract.

In nucleus lateralis tuberis (NLT), the neurosecretory cells were distributed in the ventral floor of brain adjacent to the pituitary stalk. These cells were negative to aldehyde fuchsin (AF) and chrome-alum-hematoxylin-phloxine (CAHP) but stained readily with acid fuchsin in Mallory's triple stain (Fig. 8). Based on cell distribution and size, the NLT was divisible into pars anterior, pars posterior and pars inferior. The neurosecretory cells of NLT were variously shaped and their sizes ranged from very small to the larger ones with polymorphic nuclei (Fig. 8). These neurons are generally bipolar but a few multipolar cells are also observed in NLT of *Heteropneustes fossilis*. NLT was highly vascularized structure and a few neurosecretory cells were seen in close association of blood vessels. Acid fuchsin-positive neurosecretory materials were rarely located in the NLT cells (Fig. 8). The neurohypophysial tract (NHT) entered the hypophysis through infundibulum.

DISCUSSION

The basic cytoarchitectural pattern of hypothalamo-neurosecretory system of *Heteropneustes fossilis* resembles to those reported for a number of freshwater teleosts (Sathyanesan, 1965; Bhargava, 1969; Sundararaj and Viswanathan, 1971; Chandrasekhar and Khosa, 1972; Saksena, 1979; Maksimovich, 1987). Generally, the neurosecretory cells of NPO stain with AF and CAHP but they are also stainable with acid fuchsin in *Heteropneustes fossilis*. Similar staining responses have also been recorded in freshwater clupeid, *Notopterus chitala* (Prakash *et al*., 1984), Indian mackerel, *Rastrelliger kanagurta* (Pandey, 1993a), scad, *Megalaspis cordyla* (Pandey, 1993b) and Indian scad, *Decapturus tabl* (Pandey and Mohamed, 1993). There are reports that NPO is involved in spawning activities and its secretions do influence gonadal maturation among teleosts (Viswanathan and Sundararaj, 1974a,b; Zolotintskiy, 1980; Prakash *et al*., 1984; Rai and Pandey, 1986; Subhedar *et al*., 1999). Viswanathan and Sunderaraj (1974a,b-*Heteropneustes fossilis*), Tischenko *et al*. (1976-*Coregonus autumnalis migratorius*), Saksena (1979-*Glossogobius giuris*), Zolotnitskiy (1980-*Scopthalamus maeoticus*) and Rai and Pandey (1986-*Colisa fasciata*) noticed depletion of neurosecretory material during breding season or after estrogen administration.

Though acid fuchsin-positive glouble-like neurosecretory materials have been recorded in PMC and PPC cells of *Porichthys notatus* (Sathyanesan, 1965), *Phoxinus phoxinus* (Bhargava, 1969), *Channa punctatus*, *Clarais batrachus* and *Heteropneustes fossilis* (Chandrasekhar and Khosa, 1972), *Glossogobius giuris* (Saksena, 1979), *Scophthalamus maeoticus* (Zolotnitskiy, 1980), *Notopterus chitala* (Prakash *et al*., 1984), *Rastrelliger kanagurta* (Pandey, 1993a), *Megalaspis cordyla* (Pandey, 1993b), *Decapterus tabl* (Pandey and Mohamed, 1993) and *Lates calcarifer* (Lal and Pandey, 1998), we could rarely locate such structure in NPO and NLT of *Heteropneustes fossilis*. This may probably be due

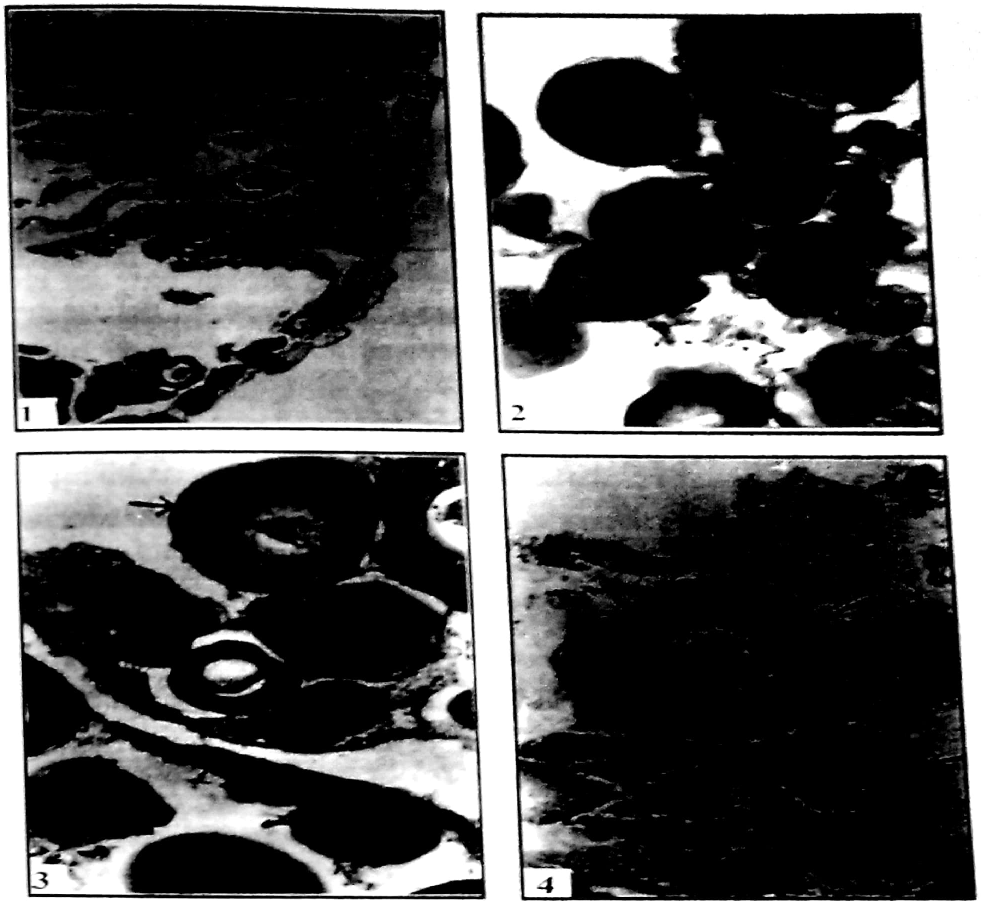

Fig. 1. Ovary of *Heteropneustes fossilis* in December showing oocytes in the early stages of development. Mark the oogonia arising from germinal epithelium (arrow) and undischarged mature oocytes (broken arrow). H&E. x 100.

Fig. 2. Ovary of *Heteropneustes fossilis* in January exhibiting oocytes in stage 1. H&E. x 200.

Fig. 3. Ovary ofs *Heteropneustes fossilis* in February depicting oocytes in early stage 2. A few oocytes in perinucleolar stage are also seen (arrow). H&E. x 200.

Fig. 4. Ovary of *Heteropneustes fossilis* in March showing oocytes in late stage 2 of the development. Mark the oocytes in perinucleolar stage (arrow) and atretic follicles (broken arrow). H&E. x 200.

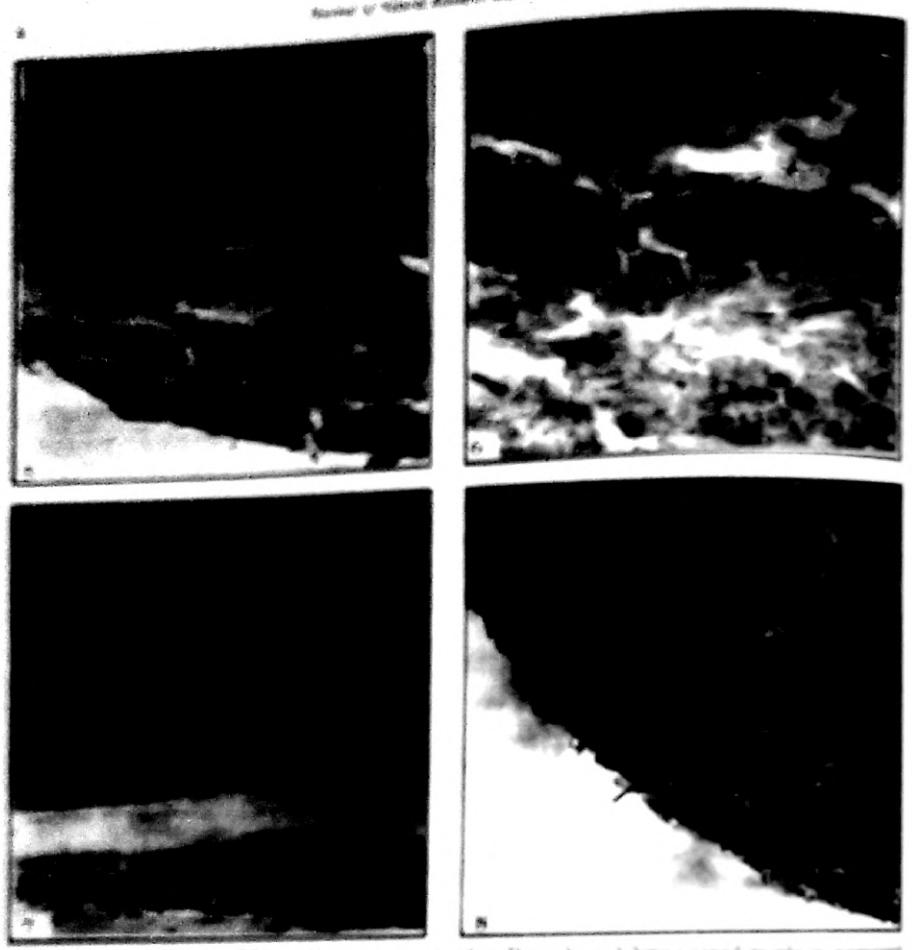

Fig. 5. Preoptic pars ventralis (PPV) of *Heteropneustes fossilis* in December exhibiting gonadal cycle in quiescent (resting) phase of secretory activity. Mallory's triple × 400

Fig. 6. PPV of *Heteropneustes fossilis* in March depicting increase in cell size and accumulation of secretory material in gonadotrophs (arrow). Mallory's triple × 600

Fig. 7. Nucleus preopticus (NPO) of *Heteropneustes fossilis* showing dorsal pars magnocellularis (PMC) and ventral pars parvocellularis (PPC). Mallory's triple × 400

Fig. 8. Nucleus lateralis tuberis (NLT) of *Heteropneustes fossilis* exhibiting distribution of the polymorphic neurosecretory cells on ventral floor of brain. Mark the acid fuchsin-positive colloid-like material (arrow). Mallory's triple × 600

to the fact that the catfish were in the early stages of ovarian maturation.

Nucleus lateralis tuberis (NLT) is the second neurosecretory centre in the teleostean hypothalamus, however, there are reports of its absence in a few fishes (Charlton, 1932; Kobayashi *et al*., 1959; Saksena, 1970; Prakash *et al*., 1984; Maksimovich, 1987). However, Kobayashi *et al*. (1959) had remarked that season or age factor might be responsible for the absence of stainable neurosecretory material in the NLT. The neurosecretory cells of NLT pars anterior, pars posterior and pars inferior of *Heteropneustes fossilis* stained readily with acid fuchsin. NLT cells of *Rastrelliger kanagurta* (Pandey, 1993a) and *Sc. grunniens* Pandey and Mohamed, 1993) also exhibited almost similar staining response. NLT cells of *Heteropneustes fossilis* (Viswanathan and Sundararaj, 1974a,b) and *Clarias batrachus* (Rai and Pandey, 1986) get stimulated during breeding season or after estrogen administration indicating its role in the reproductive physiology of the fish. Though Herring bodies (HB) have been recorded in the anterior and posterior neurohypophyses of *Poecilichthys notatus* (Sathyanesan, 1965), *Phoxinus phoxinus* (Bhargava, 1969), *Liposagobius gilberti* (Saksena, 1979), *Scophthalamus maeoticus* (Zolotnitskiy, 1980), *Rastrelliger kanagurta* (Pandey, 1993a) and *Dicentrarchus labrax* (Pandey and Mohamed, 1993), such structures were not encountered in the neurohypophysis of *Heteropneustes fossilis*. Herring bodies are assumed to be the accumulated neurosecretory material (Sathyanesan, 1965; Bhargava, 1969; Saksena, 1979; Zolotnitskiy, 1980).

ACKNOWLEDGEMENT

We are grateful to Dr. S. Ayyappan, former Director, Central Institute of Freshwater Aquaculture, Bhubaneswar for providing laboratory facilities to carry out the work.

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Journal of Natural Resource and Development 2(1):7-10, 2007

IMMUNO-HAEMATOTOXIC EFFECTS OF CHRONIC CADMIUM ACETATE ADMINISTRATION IN WHITE LEG-HORN CHICKS

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ABSTRACT

Sublethal dose (6.8 mg/kg body weight; 0.10 LD_{50} value for 96 hours) administration of cadmium acetate for 16 and 32 days induced immuo-haematotoxicity in white leg-horn chicks. Haematological parameters like totai erythrocyte count (TEC), haemoglobin content (Hb), packed cell volume (PCV) and mean corpuscular haemoglobin concentration (MCHC) recorded a significant decline on day 16 and 32 while mean corpuscular volume (MCV) and mean corpuscular haemoglobin (MCH) registered an elevation on the corresponding days. Though total leucocyte count (TLC) also recorded a significant increase on day 16 but the value declined by day 32. The probable causes of anaemia in the chick due to sublethal cadmium toxicity have been discussed.

Key words : Cadmium acetate, anaemia, immuno-haematotoxic, chicks.

Cadmium pollution in the environment is increasing due to industrial and agricultural practices. Cadmium is toxic to liver, kidney, testes, bone and immune system (Friberg *et al.*, 1986; Goering *et al.*, 1995). Itai-itai disease is caused by long-term exposure of cadmium in Toyama Prefecture of Japan. Patient with itai-itai disease showed various symptoms including nephropathy, osteomalacia, anaemia, diarrhea, vomitting and severe pain (Friberg *et al.*, 1986). Anaemia is a major haematotoxic effect following long-term exposure to Cd in human (Noda *et al.*, 1991; Horiguchi *et al.*, 1994) and laboratory animals (Lutton *et al.*, 1984; Sakata *et al.*, 1988; Hiratsuka *et al.*, 1996). Cadmium also produced immunotoxicity (Descotes, 1992), dose-dependent inhibition of phytohaemo-glutinine induced human lymphocyte proliferation *in vitro* (Kastelan *et al.*, 1981) and increased monocytes. There are instances of increased monocytes count in workers exposed to cadmium (Karakaya *et al.*, 1994). At low dose of exposure, cadmium has been shown to enhance humoral responses (Fujimaki *et al.*, 1981) whereas high dose of the toxic metal results is decreased B-cell function (Koller 1980; Lawerence, 1981; Stelzer and Pazdernik 1983; Daum *et al.*, 1993). In comparison, T-cell mediated immunity has been shown to be consistently depressed by cadmium treatment (Gaworski and Sharma, 1978; Borgman *et al.*, 1986). Similarly, phagocytosis, natural killer activity and host resistance to infection are markedly impaired in most instances (Loose *et al.*, 1978; Nelson *et al.*, 1982; Cifone *et al.*, 1989). An attempt has been made to record the immuno-haematotoxic effects of chronic cadmium acetate treatment in white leg-horn chicks.

MATERIALS AND METHODS

Newly hatched white leg-horn (WLH) chicks were obtained from M/S Salim Hatchery, Meerut. They were kept in clean wood and steel cages in animal house and acclimatized to the laboratory conditions (temperature 36 ± 2°C, photoperiod 14L : 10D hours) for one week before initiation of the experiment. The chicks were fed formulated chicks feed (Hindustan Poultry Feed Ltd.) and body weight recorded on the alternate day. Feeding was stopped 24 hours before commencement of experiment to avoid metabolic variations due to diet. Various doses of cadmium acetate (BDH India Ltd., Mumbai) were prepared by dissolving in distilled water. LD_{50} dose

for 96 hours of cadmium acetate to chicks were calculated and found to be 68 mg/kg body weight through oral intubation. The acclimatized chicks were divided into two equal groups. The chicks of Group 1 were not given any treatment (control) while those of Group 2 received sublethal dose (6.8 mg/ml; 0.10 LD_{50} for 96 hours) of cadmium acetate (experimental).

Blood samples of both the groups were collected directly from heart on day 16 and 32. Total erythrocyte count (TEC), haemoglobin content (Hb), total leucocyte count (TLC), packed cell volume (PCV) was done by haemoglobinometer, haematocrit tube and haemocytometer (Wintrob's tube). Values of mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH) and mean corpuscular haemoglobin concentration (MCHC) were calculated as these parameters depend on the corresponding values of Hb, TEC and PCV. The results were evaluated for statistical significance by using Students 't' test.

RESULTS AND DISCUSSION

Variations in TEC, Hb, TLC, PCV, MCV, MCH and MCHC due to sublethal cadmium acetate treatment in chicks have been summarized in Table 1. Haematological parameters like total erythrocyte count (TEC), haemoglobin content (Hb), packed cell volume (PCV) and mean corpuscular haemoglobin concentration (MCHC) of the cadmium acetate treated chicks recorded a significant decline on day 16 and 32 while mean corpuscular volume (MCV) and mean corpuscular haemoglobin (MCH) registered an elevation on the corresponding day. Though total leucocyte count (TLC) of the experimental chicks also recorded a significant increase on day 16 but the value declined by day 32.

In the present study, effects of sublethal oral administration of cadmium acetate on haemopoietic and immune system in white leg-horn chicks have been recorded. The treatment induced anaemia in chicks on day 16 and 32 which was evident by decreased erythrocyte (RBC) count, haemoglobin (Hb) concentration, haematocrit (PCV) and MCHC. Occurrence of anaemia is a common finding in animals after oral as well as parenteral exposure to cadmium (Friberg *et al.*, 1986). Though the mechanism of cadmium induced anaemia is not completely understood, it might be due to: (i) iron deficiency due to inhibition of non-absorption toxicant in the gastrointestinal tract (Schaefer and Elsenhans, 1985), (ii) hypoplastic anaemia derived from the inhibitory effect of cadmium on the growth of erythroid proginator cells (Lutton *et al.*, 1984; Sakata *et al.*, 1988), (iii) haemolytic anaemia due to red blood cells sequestration in spleen (Kunimoto and Miura, 1986) resulting in a shorter life span and increased destruction of red blood cells in the spleen and liver (Tanaka *et al.*, 1987) and (iv) hypoproduction of erythropoietin due to renal injury (Horiguchi *et al.*, 1994).

The present study provides evidence to support these hypotheses. Significant increase in MCV and decrease in MCHC (Table 1) support the suggestion that iron deficiency might contributed to the development of anaemia in cadmium treated chicks (Kostic *et al.*, 1993). Since the degree of anaemia

Table 1: Haematological responses of white leg-horn chicks treated with cadmium acetate.

Parameters	16 Days		32 Days	
	Control	Experimental	Control	Experimental
RBC(million/ mm³)	3.94 ±0.21	2.54 ±0.25*	4.00 ±0.29	2.80±0.22*
Hb (mg/dl)	12.50±0.20	10.50±0.21**	10.90 ±0.23	9.00±0.29**
TLC(million/ mm³)	9,000±15.59	10,900±21.36**	8,500 ± 28.87	7,000±14.43**
PCV (%)	31.00±0.43	28.00±0.23**	28.00 ±0.17	25.00±0.29**
MCV (μ³)	78.68±0.24	110.23±0.70**	70.30±0.46	89.30±1.50**
MCH (pg)	31.72±0.28	46.06±0.12**	27.25±0.55	32.14±0.89**
MCHC (%)	40.30±0.33	38.93±0.03**	39.00±0.31	36.00±0.44**

Values are mean ± S.E. of 5 chicks. Significant responses: *P<0.01,** P<0.001.

paralleled the cadmium induced renal injury (Hu *et al.*, 1998) suggesting to the possible reduction of erythropoietin production due to cadmium nephrotoxicity (Horiguchi *et al.*, 1994; Hiratsuka *et al.*, 1996). These factors might contribute to the cadmium induced anaemia. Cadmium induced immunotoxicity is concern as conflicting observations have been reported (Koller, 1980; Descotes, 1992). The discrepancies may probably be due to the route, dose and duration of exposure to the experimental animals.

ACKNOWLEDGEMENT

We are thankful to Prof. S.V.S. Rana, Head, Department of Zoology, C.C.S. University, Meerut for providing necessary laboratory facilities to carry out the work.

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Journal of Natural Resource and Development 2(1):11-14, 2007

GROWTH AND PERFORMANCE OF BROILERS AS INFLUENCED BY SUPPLEMENTATION OF *TERMINALIA ARJUNA* IN RATION

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ABSTRACT

An experiment on supplementation of *T. arjuna* in ration of broilers was conducted to determine growth and performance. Seventy-five day old chicks of same hatch were divided into 5 groups of 15 each and fed ration containing 0.25, 0.5, 0.75 and 1 percent *T. arjuna*. Data on weekly body weight feed consumed, gain in weight, feed conversion ratio, blood parameters namely total cholesterol, triglyceride, glucose and total protein *etc.* were collected and analyzed statistically. Performance of broilers adjudged on the basis growth and feed efficiency indicated that there was no significant affect of *T. arjuna* supplementation on growth and feed efficiency of broilers. However, significant effect on cholesterol and triglycerides in blood serum was observed which significantly reduced by 1 percent addition of *T. arjuna* in ration.

Key words : Broilers, supplementation, T. arjuna.

Feed for chickens under intensive poultry farming constitutes 70 to 75 percent cost of expenditure in poultry production (Prasad, 2005). A continuous search for new feed additives is being made by nutritionists to exploit genetic potential of broilers for better growth and performance. Ayurvedic preparations of herbal origin have been reported to improve overall performance of broilers and profitability (Prasad and Sen, 1993; Ali et. al. (1994). In this context bark powder of T. arjuna known to have pharmacological properties like antimutagenic, anticarcinogenic, antianginal, spasmonogenic, oxytoxiz, antifertility, hypertensive, astringent, haemostatic was used to determine performance of broilers on ration supplemented with *T. arjuna* in the present investigation.

MATERIALS AND METHODS

75 day old commercial broiler chicks of same hatch were divided into five groups of 15 chicks each. Chicks of one group were fed control ration without *T. arjuna* (T_0) and remaining four groups were kept for treatments *viz.* T_1, T_2, T_3 and T_4 in which chicks were fed standard rations containing 0.25, 0.5, 0.75 and 1 percent *T. arjuna* bark powder. Chicks were maintained in battery type metal cages with sufficient space (0.75 sq. ft. per chick) under similar management conditions. Chicks of control and all treatments were fed standard isocalorie and protein broiler starter ration upto 3 weeks and then finisher ration *ad. libiturn.* upto 6 weeks. Fresh water was made available at all times. A 15 watt bulb was left on in each cage during night. The data on weekly body weight, feed consumption, gain in weight, feed conversion ratio were collected and analyzed statistically. At the end of experiment two birds from each treatment were sacrificed for collecting blood samples for estimation of total cholesterol serum glucose triglycerides, total serum protein and albumin according to methods of Allen (1974), Trinder (1969), Werner *et. al.* (1981), Henry *et. al.* (1974) and Webster *et. al.* (1977) respectively. Globulin protein was determined by difference (Serum globulin Total serum protein–albumin) per 100 ml. Carcass characteristics were determined as per the procedure given by Prasad (2005).

RESULTS AND DISCUSSION

Initial mean body weight of day old chick

(DOC) in different treatments ranged from 42.20 to 44.13 g The differences in the initial body weight of DOC between treatments were non-significant. The mean body weight at six weeks of age in T_0, T_1, T_2, T_3 and T_4 was 1.964, 1.852, 1.958, 1.993 and 2.055 kg. respectively. The differences in these values were significant. The highest mean feed intake per broiler during six weeks was recorded as 3.563 (kg) in T_4 followed by 3.558 kg in T_3, 3.534 kg in T_0, 3.513 kg in T_2 and 3.370 kg in T_1. The differences in these were non-significant. Highest gain in weight in broilers during six weeks was recorded in T_4 (2.012 kg) followed by T_3 (1.949 kg), T_0 (1.917 kg), T_2 (1.915 kg) and T_1 1.808 kg) and the differences in these were also non-significant. Similarly, the best FCR (feed required for per kg gain in weight) per broiler was recorded as 1.77 in T_4 followed by 1.83 in T_3, 1.834 in T_2, 1.839 in T_0 and 1.86 in T_1. The differences in these were non-significant.

Chemical Prameters

Lowest mean total cholesterol per 100 ml blood serum was observed as 126.5 mg in broiler of T_4 followed by 131.5 mg 131.5 mg in T_3, 144.5 mg in T_2, 150.83 mg in T_1 and 179.3 mg in T_0 and the differences in these were found significant. These results are in agreement with Alpana *et. al.* (1997). Broiler of control group had significantly higher cholesterol than broiler of treatment group. Lowest mean triglyceride per 100 ml. blood serum was observed as 46.50 mg. in broiler of T_4 followed by 54.50 mg. in T_3, 61.17 mg. in T_2, 64.33 mg. in T_1 and 72.83 mg in T_0 and the differences in these were found significant. Broiler of control group registered significantly high triglyceride than broiler of treatment group. Lowest mean glucose per 100 ml., of blood serum was observed in broiler of T_4 (160.5 mg.) followed by T_3 (178.5 mg.), T_2 (179.8 mg.), T_1 (189.1 mg.) and T_0 (213.5 mg.) and the differences in these were significant. Broiler of T_4 registered significantly less glucose in blood serum than broiler of control group (T_0). These results are in agreement with Gupta *et. al.* (2001) and Ali *et. al.* (2003). Lowest total serum protein per 100 ml of blood was recorded in broiler of T_3 (4.57 g) followed by T_1 (4.60 g), T_0 (4.67 g), T_2 (4.78 g) and T_4 (4.87 g) and the differences in these were non-significant.

Lowest mean albumin per 100 ml of blood was recorded in broiler of T_3 (2.58 g) followed by T_1 (2.63 g), T_0 (2.73 g), T_4 (2.77 g) and T_2 (2.83 g) and the differences in these were non-significant. Lowest percent weight of blood of broilers was recorded in broiler of T_0 (3.05) followed by T_1 (3.25), T_4 (3.43), T_2 (3.53) and T_3 (4.32) and the differences in these were non-significant. Lowest percent weight of feather with skin of broilers was recorded in broiler of T_2 (13.51) followed by T_1 (13.74), T_3 (13.95), T_0 (14.02) and T_4 (14.28) and the differences in these were non-significant. Lowest percent weight of head of broilers was recorded in broiler of T_4 (2.50) followed by T_1 (2.63), T_2 (2.65), T_3 (2.66) and T_0 (2.98) and the differences in these were found to be significant. Lowest percent weight of trotters of broilers was recorded in broiler of T_1 (4.79) followed by T_4 (5.28), T_3 (5.43), T_2 (5.61) and T_0 (5.68) and the differences in these were found to be signi ficant. Lowest percent weight of giblet of broilers was recorded in broilers of T_3 (4.02) followed by T_4 (4.15), T_2 (4.27) and T_1 (4.42) and the differences in these were non-significant. Lowest percent weight of liver of broilers was recorded in broiler of T_3 (1.80) followed by T_2 (1.90), T_0 (1.95), T_4 (1.98) and T_1 (2.20) and the differences in these were non-significant. Lowest percent weight of intestine of broilers was recorded in broiler of T_3 (6.45) followed by T_4 (6.75), T_2 (6.91), T_1 (7.15) and T_0 (7.28) and the differences in these were non-significant. Highest dressing percentage of broilers was recorded of T_1 (64.02) followed by T_3 (63.76), T_4 (63.62), T_2 (63.53) and T_0 (62.66) and the differences in these were non-significant.

Carcass Characteristics

Percentage of blood of body weight of broiler in T_0, T_1, T_2, T_3 and T_4 was 3.05, 3.25, 3.53, 4.32 and 3.43, respectively. Feather with skin of broilers in T_0, T_1, T_2, T_3 and T_4 was 14.02, 13.74, 13.51, 13.95 and 14.28 percent respectively of their body weights. The differences in percent of blood and skin

Table 1 Ascending/descending order mean value of different parameters in broilers.

S.N.	Parameters	Treatments					C.D.
1.	Body weight of day old chicks (g)	44.13 T_1^a	43.93 T_3^a	43.67 T_2^a	43.33 T_0^a	42.40 T_4^a	—
2.	Final body/weight of 6 weeks of age (kg)	2.055 T_4^b	1.993 T_3^b	1.964 T_0^{ab}	1.958 T_2^{ab}	1.852 T_1^a	0.13
3.	Total feed intake per broiler in 6 weeks (kg)	3.563 T_4^a	3.558 T_3^a	3.534 T_0^a	3.513 T_2^a	3.370 T_1^a	—
4.	Average weight gain in 6 weeks (kg)	2.012 T_4^a	1.949 T_3^a	1.921 T_0^a	1.915 T_2^a	1.808 T_1^a	—
5.	Feed conversion ratio (FCR)	1.77 T_4^a	1.77 T_4^a	1.834 T_2^a	1.839 T_1^a	1.86 T_1^a	—
6.	Total cholesterol in blood serum (mg/100 ml)	126.50 T_4^c	131.50 T_4^{bc}	144.50 T_2^{bc}	150.83 T_1^b	179.30 T_0^a	23.89
7.	Triglyceride in blood serum (mg/100 ml)	46.50 T_4^c	54.50 T_3^{bc}	61.17 T_2^{ab}	64.33 T_1^{ab}	72.83 T_0^a	10.71
8.	Glucose in blood serum (mg/100 ml)	160.50 T_4^b	178.50 T_3^{ab}	179.80 T_2^{ab}	189.10 T_1^{ab}	213.50 T_0^a	43.67
9.	Total protein in blood serum (g/100 ml)	4.57 T_3^a	4.60 T_1^a	4.67 T_0^a	4.78 T_2^a	4.87 T_4^a	—
10.	Albumin in blood serum (g/100 ml)	2.58 T_3^a	2.63 T_1^a	2.73 T_0^a	2.77 T_4^a	2.83 T_2^a	—
11.	Globulin in blood serum (g/100 ml)	1.93 T_0^a	1.94 T_2^a	1.97 T_1^a	1.98 T_3^a	2.10 T_4^a	—
12.	Percent weight of blood of broilers	3.05 T_0^a	3.25 T_1^a	3.43 T_4^a	3.53 T_2^a	4.32 T_3^a	—
13.	Percent weight of feather with skin of broilers	13.51 T_2^a	13.74 T_1^a	13.95 T_3^a	14.02 T_0^a	14.28 T_4^a	—
14.	Percent weight of head of broilers	2.50 T_4^b	2.63 T_1^b	2.56 T_2^B	2.66 T_3^B	2.98 T_0^a	0.238
15.	Percent weight of trotters of broilers	4.79 T_1^b	5.28 T_4^{ab}	5.43 T_3^a	5.61 T_2^a	5.68 T_0^a	0.555
16.	Percent weight of giblet of broilers	4.02 T_3^a	4.15 T_4^a	4.27 T_2^a	4.33 T_0^a	4.42 T_1^a	—
17.	Percent weight of liver of broilers	1.80 T_3^a	1.90 T_2^a	1.95 T_0^a	198 T_4^a	2.20 T_1^a	—
18.	Percent weight of intestine of broilers	6.45 T_3^a	6.75 T_4^a	6.91 T_2^a	7.15 T_1^a	7.28 T_0^a	—
19.	Dressing Percentage of broilers	62.66 T_0	63.53 T_2	63.62 T_4	63.76 T_3	64.02 T_1	—

with feather of the body weight between treatments were not significant.

Percent weight of head and body weight of broilers in T_0, T_1, T_2, T_3 and T_4 was 2.98, 2.63, 2.65, 2.66 and 2.5, respectively and the differences in these were significant. Broilers of control group had significantly higher percentage of head than treatments but the differences in this in broilers of treatments were not significant. Percent of trotters of body weight in broilers of T_0, T_1, T_2, T_3 and T_4 was 5.68, 4.79, 5.61, 5.43 and 5.28 and the differences in there were also significant. Broilers of T_1 had significantly less percent weight of trotters than broilers of control and other treatments except T_4 which were at par.

Lowest percentage of giblet of body weight of body of broilers in T_0, T_1, T_2, T_3 and T_4 was 4.33, 4.42, 4.27, 4.02 and 4.15, respectively. Similarly the corresponding values of liver percentage was 1.95, 2.20, 1.9, 1.8 and 1.98. Percentage of intestine of broilers body weight in T_0, T_1, T_2, T_3 and T_4 was 7.28, 7.15, 6.91, 6.45 and 6.75, respectively but the difference in values of giblets, liver and intestine of broilers of control and treatment were found non-significant. The dressing percentage of broilers in T_0, T_1, T_2, T_3 and T_4 was 62.66, 64.82, 63.53, 63.76 and 63.62, respectively and these also did not differ significantly in broilers of control compared to treatments.

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Journal of Natural Resource and Development 2(1):15-20, 2007

STUDY ON THE EFFECT OF *RHIZOBIUM* INOCULANT, SOIL TEXTURAL CLASSES, PESTICIDES AND SEWAGE TREATMENT ON NODULATION OF GREEN GRAM [*VIGNA RADIATA* (L.) WILCZEK.]

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ABSTRACT

An attempt has been made in the present investigation to analyse the interaction of *Rhizobium* inoculant, soil textural classes, pesticides and sewage treatment on nodulation of green gram to determine the compatibility among them, so that these treatment can be recommended to promote nodulation in green gram, without affecting the nitrogen fixing and nodule forming ability of *Rhizobium*. In the present study, statistical analysis indicates that different treatments show different level of significance with regard to nodulation.

Key words: *Rhizobium inoculant, soil textural classes, pesticides, sewage, green gram, nodulation.*

Pulse crops have been valued as food, fodder and feed, and thus have remained as mainstay of Indian agriculture for centuries. These are major factor responsible for sustaining soil fertility because of their ability to fix atmospheric nitrogen in symbiotic association with *Rhizobium*. Fungicides help in combating plant diseases. The present investigation provides information on the interaction between *Rhizobium* inoculant, soil textural classes, pesticides and sewage treatment on nodulation in green gram. Root nodule bacteria *Rhizobium* lives freely in soil and in the rhizosphere region of leguminous plants. The organism can infect the roots of many of the members of Fabaceae Family only and produce root nodules on them. Boussingault (1837) was the first to point out the nitrogen fixing capability of these plants. Pesticides according to their chemical composition may affect the soil microorganisms including *Rhizobium* in various ways. They may inhibit or reduce growth or they may react with microbial products. The equilibrium in the soil biotic community changes constantly due to soil environment and also due to normal fluctuations in the abiotic condition of the soil. The increasing number and wide spread use of these potent chemicals has aroused concern for the possible injurious effects on soil microorganism and their activities of significance in soil. Numerous studies have been devoted to the side effects of pesticides (Agnihotri, 1971; Brown, 1975; Tu, 1980; Pati 2006). Donolo *et al.* (1998) found that Vitavax application decreased the growth of *Bradyrhizobium* of groundnut by 73% in pure culture. Kumar *et al.* (2002) while evaluating the compatibility of Mancozeb, Bavistin and Captafol with *Rhizobium* strains DG-48 as seed treatment for chickpea reported that pesticide treated and *Rhizobium* inoculated seeds showed enhanced nodulation and increase fresh and dry weight of seeds over the control by 16.67%. Kumar (2002) reported in chickpea that seed treatment with pesticides followed by *Rhizobium* inoculation had no adverse effect on seed germination, it also enhanced nodulation by 10-30%. Pati and Shukla (2006) reported that fungicide Bavistin was effective in producing better and beneficial effect on nodulation, growth and yield in green gram. Pati (2007) analysed the effect of fungicides and rhizobial inoculant on the yield of green gram and reported that Thiram and Bavistin to be more effective then others.

MATERIALS AND METHODS

The study was conducted at Department of Botany, Harish Chandra P.G. College, Varanasi. Nodulation of green gram plant was taken into

consideration, with regard to their compatibility with different treatments. K-851 variety of *Vigna radiata* was used. The parameters studied was nodulation and treatment considered where as follows; Control (T_0), *Rhizobium* inoculated (T_1), Sand (T_2), Loam (T_3), Silt (T_4), Clay (T_5), Thiram (T_6), Captain (T_7), DM-45 (T_8), Metasystox (T_9), Temik (T_{10}), Malathion (T_{11}) and Sewage (T_{12}). For preparation of *Rhizobium* inoculum, carrier based culture were suspended in 10% of Jaggery solution using the method as described by Tilak (1991). The required dilution of fungicides was prepared by taking ppm or percentage into consideration. The actual quantity of formulated product was calculated by considering percentage of active ingredient present in the product. The pesticides considered were as follow 0.25% Thiram (tetra methyl thirum disulphide), 0.3% Dithane M-45 (75% WP manganese ethylene bis dithioarbamate plus zinc), 0.25% Captan (N-tri chloro methyl tiro)-4 cyclo hexane-1,2 dicarboximide), 0.1% Metasystox (O,O-Diethyl-S- (ethylthio) methyl) phosphorodithioate, 0.1% Malathion and 10% Temik 2-Methyl-2- (methylthio propionaldehydro O-(methylcarbomoyl). The soil textural classes considered were Sand, Loam, Silt and Clay. Sewage treatment was also applied. Pot culture experiment with pesticides were undertaken in Kharif season of the year 2006. Soil used for the pot culture experiment was air-dried and crushed with roller, it was sieved and representative soil sample was taken for the purpose of analysis. Earthern pots were filled with the above soil at the rate of 5 kg/pot. The pH of the soils was 7.1.

The data analysis was carried out through the technique of one way Analysis of Variance (ANOVA), using F-test of significance, under the one way null hypothesis* that there is no difference among treatment means. Each treatment table has been supplemented by the ANOVA table and also the SNK test (q value) as per need *i.e.* when the F value obtained is found to be significant. If F is significant at 5 percent level, it has been marked with single star (*), if it is significant at 1% then it is marked with double star (**), if it is significant at 0.1% then it will be marked with triple star (***) and if it is insignificant then it is marked by (NS).

RESULTS AND DISCUSSION

This study was planned primarily to investigate the effect of soil textural classes, *Rhizobium* inoculation, pesticides application and sewage treatment on nodulation in green gram, In *Vigna radiata* the effect of these treatment was significant at 0.1% level of significance. *Rhizobium* inoculation and sand were most effective in promoting nodule numbers per plant while pesticides application proved detrimental, particularly fungicide Thiram and Captan which greatly reduced the nodule number. Analysing the effect of theses treatments on nodulation (nodules per plant) in green gram, it is concluded that, there exist diversity in the effect of these treatments, with regard to various parameters taken in the present investigation, but pesticidal treatments are must for controlling pathogen and increasing productivity. However, the need for investigating the compatibility between beneficial microorganism like *Rhizobium* and pesticides prior to their application must not be ignored in any case. Soil textural classes too play an important role particularly in nodule-forming plants. It was observed that loose textured soil like sand promotes the formation of nodules by enhancing aeration while clay soil inhibits nodule number.

Table 1(1) : Character-Number of nodules per plant of *Vigna radiata*

S. No	Treatments	Replicate-3 Total No. 3x13=39				Mean	Std. Deviation	Std. Error	95% Confidence interval for mean	
		R_1	R_2	R_3	Total				Lower bound	Upper bound
1	Control (T_0)	8	8	9	25	8.3333	0.5774	0.3333	6.8991	9.7676
2	*Rhizobium* inoculated (T_1)	20	23	21	64	21.3333	1.5275	0.8819	17.5388	25.1279
3	Sand (T_2)	15	17	16	48	16.0000	1.0000	0.5774	13.5159	18.4841
4	Loam (T_3)	15	16	16	47	15.6667	0.5774	0.3333	14.2324	17.1009
5	Silt (T_4)	17	16	16	49	16.3333	0.5774	0.3333	14.8991	17.7676
6	Clay (T_5)	10	10	9	29	9.6668	0.5774	0.3333	8.2324	11.1009
7	Thiram (T_6)	5	7	8	20	6.6667	1.5275	0.8819	2.8721	10.4612
8	Captain (T_7)	6	8	8	22	7.3333	1.1547	0.6667	4.4649	10.2018
9	DM-45 (T_8)	7	8	8	23	7.6667	0.5774	0.3333	6.2324	9.1009
10	Metasystox (T_9)	18	20	19	57	19.0000	1.0000	0.5774	16.5159	21.4841
11	Temik (T_{10})	8	9	9	26	8.6667	0.5774	0.3333	7.2324	10.1009
12	Malathion (T_{11})	10	11	11	32	10.6667	0.5774	0.3333	9.2324	12.1009
13	Sewage (T_{12})	12	12	11	35	11.6667	0.5774	0.3333	10.2324	13.1009
	Total	**151**	**165**	**161**	**477**	**12.2308**	**4.7984**	**0.7684**	**10.6753**	**13.7862**

Table 1(2) : ANOVA indicates a significants difference between various treatment at 0.1% level

Source of Variation	Sum of Squares	df	Mean Square	F cal	Ftab 5%	1%	0.1%
Between Groups	853.590	12	71.132	86.693 (***)	2.056	2.779	3.707
Within Groups Total	21.333	26	0 87.1				
Total	**874.923**	**38**					

Table 1(3) : SNK (Student - Newman-Keul) test value

S.No	Treatment Comparison	qCal	q tab 5%	1%	0.1%	P
1	*Rhizobium* Versus Thiram	19.82***	5.179	7.01	7.55	13
2	*Rhizobium* Versus Captan	18.93***	5.09	6.10	7.46	12
3	*Rhizobium* Versus DM-45	18.47***	5.01	6.01	7.37	11
4	*Rhizobium* Versus Control	17.57***	4.91	5.91	7.27	10
5	*Rhizobium* Vesus Temik	17.12***	4.80	5.80	7.15	9
6	*Rhizobium* Versus Clay	15.77***	4.68	5.68	7.03	8
7	*Rhizobium* Versus Malathion	14.41***	4.54	5.54	6.88	7
8	*Rhizobium* Versus Sewage	13.06***	4.37	5.37	6.71	6
9	*Rhizobium* Versus Loam	7.65***	4.16	5.16	6.50	5
10	*Rhizobium* Versus Sand	7.21***	3.90	4.90	6.23	4
11	*Rhizobium* Versus Silt	6.76***	3.53	4.54	5.87	3
12	*Rhizobium* Versus Metasystox	3.15*	2.92	3.95	5.29	2

13	Metasystox Versus Thiram.	16.67***	5.09	6.10	7.46	12
14	Metasystox Versus Captan	15.78***	5.01	6.01	7.37	11
15	Metasystox Versus DM-45	15.32***	4.91	5.91	7.27	10
16	Metasystox Versus Control	14.43***	4.80	5.80	7.15	9
17	Metasystox Versus Temik	13.97***	4.68	5.68	7.03	8
18	Metasystox Versus Clay	12.61***	4.54	5.54	6.88	7
19	Metasystox Versus Malathion	11.26***	4.37	5.37	6.71	6
20	Metasystox Versus Sewage	9.91***	4.16	5.16	6.50	5
21	Metasystox Versus Loam	4.50*	3.90	4.90	6.23	4
22	Metasystox Versus Sand	4.06*	3.53	4.54	5.87	3
23	Metasystox Versus Silt	3.61*	2.92	3.95	5.29	2
24	Silt Versus Thiram	13.06***	5.01	6.01	7.37	11
25	Silt Versus Captan	12.17***	4.91	5.91	7.27	10
26	Silt Versus DM-45	11.71***	4.80	5.80	7.15	9
27	Silt Versus Control	10.82***	4.68	5.68	7.03	8
28	Silt Versus Temik	10.36***	4.54	5.54	6.88	7
29	Silt Versus Clay	9.01***	4.37	5.37	6.71	6
30	Silt Versus Malathion	7.65***	4.16	5.16	6.50	5
31	Silt Versus Sewage	6.30***	3.90	4.90	6.23	4
32	Silt Versus Loam	0.89NS	3.53	4.54	5.87	3
33	Silt Versus Sand	0.45NS	2.92	3.95	5.29	2
34	Sand Versus Thiram	12.61***	4.91	5.91	7.27	10
35	Sand Versus Captan	11.71***	4.80	5.80	7.15	9
36	Sand Versus DM-45	11.26***	4.68	5.68	7.03	8
37	Sand Versus Control	10.37***	4.54	5.54	6.88	7
38	Sand Versus Temik	9.91***	4.37	5.37	6.71	6
39	Sand Versus Clay	8.56***	4.16	5.16	6.50	5
40	Sand Versus Malathion	7.21***	3.90	4.90	6.23	4
41	Sand Versus Sewage	5.85**	3.53	4.54	5.87	3
42	Sand Versus Loam	0.45NS	2.92	3.95	5.29	2
43	Loam Versus Thiram	12.17***	4.80	5.80	7.15	9
44	Loam Versus Captan	11.17***	4.68	5.68	7.03	8
45	Loam Versus DM-45	10.82***	4.54	5.54	6.88	7
46	Loam Versus Control	9.92***	4.37	5.37	6.71	6
47	Loam Versus Temik	9.47***	4.16	5.16	6.50	5
48	Loam Versus Clay	8.11***	3.90	4.90	6.23	4
49	Loam Versus Malathion	6.76***	3.53	4.54	5.87	3
50	Loam Versus Sewage	5.41***	2.92	3.95	5.29	2
51	Sewage Versus Thiram	6.76**	4.68	5.68	7.03	8
52	Sewage Versus Captan	5.87**	4.54	5.54	6.88	7
53	Sewage Versus DM-45	5.41**	4.37	5.37	6.71	6
54	Sewage Versus Control	4.52**	4.16	5.16	6.50	5
55	Sewage Versus Temik	4.06**	3.90	4.90	6.23	4

56	Sewage Versus Clay	2.70 NS	3.53	4.54	5.87	3
57	Sewage Versus Malathion	1.35 NS	2.92	3.95	5.29	2
58	Malathion Versus Thiram	5.41*	4.54	5.54	6.88	7
59	Malathion Versus Captan	4.52*	4.37	5.37	6.71	6
60	Malathion Versus DM-45	4.06 NS	4.16	5.16	6.50	5
61	Malathion Versus Control	3.16 NS	3.90	4.90	6.23	4
62	Malathion Versus Temik	2.70 NS	3.53	4.54	5.87	3
63	Malathion Versus Clay	1.35 NS	2.92	3.95	5.29	2
64	Clay Versus Thiram	4.06 NS	4.37	5.37	6.71	6
65	Clay Versus Captan	3.16 NS	4.16	5.16	6.50	5
66	Clay Versus DM-45	2.70 NS	3.90	4.90	6.23	4
67	Clay Versus Control	1.81 NS	3.53	4.54	5.87	3
68	Clay Versus Temik	1.35 NS	2.92	3.95	5.29	2
69	Temik Versus Thiram	2.70 NS	4.16	5.16	6.50	5
70	Temik Versus Captan	1.81 NS	3.90	4.90	6.23	4
71	Temik Versus DM-45	1.35 NS	3.53	4.54	5.87	3
72	Temik Versus Control	0.46 NS	2.92	3.95	5.29	2
73	Control Versus Thiram	2.25 NS	3.90	4.90	6.23	4
74	Control Versus Captan	1.35 NS	3.53	4.54	5.87	3
75	Control Versus DM-45	0.89 NS	2.92	3.95	5.29	2
76	DM-45 Versus Thiram	1.35 NS	3.53	4.54	5.87	3
77	DM-45 Versus Captan	0.46 NS	2.92	3.95	5.29	2
78	Captan Versus Thiram	0.89 NS	2.92	3.95	5.29	2

ACKNOWLEDGEMENT

We take this opportunity to express our deep sense of gratitude and indebtedness to the Head Botany Department Harish Chandra P.G. College, Varanasi for providing the necessary laboratory facilities of carry out this work.

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Journal of Natural Resource and Development 2(1):21-23, 2007

FACTORS OF AFFECTING DRY PERIOD IN BROWN SWISS CROSSES

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ABSTRACT

A study was made to find out the effect of certain genetic and non-genetic factors on dry period in Brown Swiss crosses. Cows with 1/2 and 1/16 Brown Swiss inheritance had significantly shorter dry period than cows with 1/4 and 1/8 of Brown Swiss inheritance. Age at first calving, weight at first calving, sex and weight of calf born and season of calving had no-significant effect on dry period.

Key words *: Brown Swiss crosses, cows, period*

A dry period of 50-60 days in cows is necessary to provide rest to organs of milk secretion for building up reserve of nutrients, maintaining good level of milk production in subsequent lactation, diverting nutrition for development of fetus, to maintain health and to prevent nutritional deficiency diseases like milk fever. The wider dry period reduces economic return in exchange for feed, labour *etc* and affects subsequent lactation length as well as lactation yield (Pereira and Prasad, 1986). The shorter dry period reduces levels of immunoglobulin in first milk and also adversely affects the persistency of cows in milk in subsequent lactation. Such cows do not maintain high level of milk production and also become prone to nutritional diseases like milk fever *etc*. Therefore present study on dry period as affected by certain factors in Brown Swiss crosses was undertaken.

MATERIALS AND METHODS

Data on dry period for the present study were collected from the records maintained in the Department of Animal Husbandry, A.A.I. (D.U.) for the period 1926-1978. Housing, feeding, health care and management practices were uniform. Total of 138 records of Brown Swiss crosses were classified into four genetic groups *i.e.*, cows containing 1/2, 1/4, 1/8 and 1/16 BS inheritance. Data on age at first calving (AFC), weight at first calving (WFC), sex of calf born, weight of calf born and calving season were collected and subjected to analysis by one way classification technique using analysis of variance (F-Test), Fisher's t-test and critical differences as per the method of Snedecor and Cochran (1967).

RESULTS AND DISCUSSION

Shortest dry period (65.63 days) was recorded in cows of AFC 30-42 months followed by 67.81 days dry period in cows of AFC 18-30 months and 68 days dry period in cows of 42-54 months age at first calving. The differences in dry period due to age at first calving were non-significant. These observations do not tally with Singh and Prasad (1985) who reported the age of AFC was significantly positively correlated with the dry period.

Regarding the effect of age at first calving it was observed that shortest dry period of 35 days was recorded in cows of 225-275 kg body weight at first calving, followed by 65.65 days dry period in cows of 276-325 kg body weight and 67.34 days dry period in cows weighing above 326 kg body weight. The differences in dry period due to body weight at first calving of cows were non-significant.

With regard to effect of sex of calf born the shortest dry period of 64.39 days was recorded in cow, which produced female calves than cows produced male calves (67.13 days) and differences in dry period due to sex of calves born were non-

significant. Similar results were also reported by Singh and Prasad (1985).

With regard to effect of body weight of calf born, the shortest dry period of 63.15 days was observed in cows which produced calves of 21-25 kg body weight, followed by 66.47 days dry period in cows produced calves 17-20 kg body weight, 66.47 days dry period in cows produced calves below-17 kg, 67.19 days dry period in cows which produced calves of 26-30 kg body weight and 69.5 days dry period in cows produced calves of above-30 kg body weight. The differences in dry period due to body weight of calves born were non-significant.

Similarly when effect of Brown Swiss inheritance on dry period was noted, it was found that shortest dry period of 61.38 days was observed in cows with 1/16 Brown Swiss inheritance followed by 65.11 days dry period in cows of 1/2 Brown Swiss inheritance, 70 days dry period in cows with 1/8 Brown Swiss inheritance and 71.71 days dry period in cows with 1/4 Brown Swiss inheritance. The differences in dry period due of Brown Swiss inheritance were significant. The cows with 1/2 and 1/16 Brown Swiss inheritance registered significantly less dry period than remaining two levels of Brown Swiss inheritance. These results are agreement with Chandra Bhan and Prasad (1985).

Regarding the effect of calving season, it was noted that the shortest dry period of 63.70 days was observed in rainy season calvers, followed by 63.98 days in summer season calvers and 68.15 days in winter season calvers and the differences in dry period due to three calving seasons were non-significant, which is in agreement with the findings of Rao and Taylor (1971) and Khedkar *et al.* (1982) and Chandra Bhan and Prasad (1985).

Table 1 : Influence of various factors on dry period (DP) of Brown Swiss crosses.

1 AFC (Months)	30-42	18-30	42-54	
DP (days)	65.63a	67.81a	68a	
2 Wt of Cows (kg)	225-275	276-325	Above-326	
DCP (days)	35a	65.65a	67.34a	
3 Sex of Calf born	Female		Male	
DP (days)	64.39a		67.13a	
4 Weight of Calf Born (kg)	21-25	Upto-16	17-20 26-30	Above-30
DP (days)	63.15a	66.47a	66.47 a 67.19 a	69.5a
5 Level of BS Inheritance	1/16BS	1/2BS	1/8BS	1/4BS
CP (days)	61.38a	65.11b	70.0c	71.71c
(B) Non-Genetic				
6 Season of Calving	Rainy	Summer	Winter	
DP (days)	63.70a	63.98a	68.15a	

Note: Similar alphabets on values indicate non-significant differences between values within the parameter.

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Journal of Natural Resource and Development 2(1):24-31, 2007

CYANOBACTERIAL DIVERSITY IN RICE FIELDS AROUND VARANASI DISTRICT (U.P.)

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ABSTRACT

The diversity of cyanobacteria in 11 distantly situated rice cultivation sites was evaluated. A total of 102 cyanobacterial forms belonging to 100 species of 27 genera were identified which were mainly from 8 families of the orders Chroococcales, Pleurocapsales, Nostocales and Stigonematales. The highest relative abundance, throughout presence and the ultimate dominance towards the last parts of rice cultivation cycle reflects the highest tolerance and adaptability of heterocystous forms in comparison to others.

Key words *: Cyanobacteria, biodiversity, rice fields.*

Varanasi lies at 25°18' N latitude and 83°1' E longitude in the eastern part of the upper Gangetic plain (Fig. 1). It is about 76.19 meters above the sea level and drained by the Ganges and its tributaries. It is one of the chief rice growing districts of Uttar Pradesh. The total area of Varanasi is about 1, 52,662 hectares and 32.8% of it is devoted to rice cultivation. The year enjoys all the three important seasons, *i.e.*, rainy, winter and summer with an annual rainfall of about 1,100 mm. Rice cultivation starts from June last or July depending upon the arrival of the monsoon and extends up to November. In most part of rice cultivation cycle, fields are waterlogged, a condition that favours cyanobacterial growth.

The preponderance and importance of cyanobacteria in rice fields is well-established (Pandey, 1965; Subba Rao, 1968; Roger and Kulasooriya, 1980). Venkataraman (1961) introduced 'Algalization' practice for increasing rice yields by algal inoculation in the soil. However, the success of algalization depends largely on the efficiency of the cyanobacterial forms to adapt to the immediate ecological soil conductions, in order to survive, establish and colonize the soils in a reasonable time. Thus, it is important to timely survey and select the indigenous cyanobacterial strains. Although, cyanobacterial forms have been identified from only a part of Varanasi (Singh, 1939; Singh, 1978), the systematic exploration from all around the rice fields of Varanasi is lacking. With this in view, attempt was made to account for the diversity of cyanobacteria in the rice fields.

MATERIALS AND METHODS

The sites of rice cultivation for investigation were not only chosen from inside Varanasi district but some rice fields situated outside were also selected and encoded as A – K. The continuous collection of soil samples with blue-green algae from selected rice fields for three crop seasons during 2001 to 2003 has been done. The field data as well as algal materials were collected at nearly fixed time intervals *i.e.*, 20 - 25 days

The minimum 4 algal and soil samples were scraped and picked in specimen tubes from each collection site. A part of the samples as preserved in 4% formalin and remaining used for enrichment culture and isolation of algal forms using Allen and Arnon (1955) modified by Arnon *et al.* (1974) media. All the specimens were critically examined and various taxa identified using keys given by Desikachary (1959) and Anand (1989). The relative abundance of particular algal type was calculated by employing the formula:

Relative abundance (RA) = Y/Xx100

where, X= total numbers of samples collected; and, Y = number of samples from which a particular cyanobacterial type was identified.

CYANOBACTERIAL FORMS COLLECTED FROM VARIOUS SITES

Unicellular/colonial forms : *Microcystis aeruginosa*, *Gloeocapsa stegophila* var. *crassa* , *G. atrata*, *Gloeothece samoensis* var. *will*, *Chroococcus montanus*, *C. minutus*, *C. pallidus*, *C. varius*, *Aphanocapsa biformis*, *A. grevillei*, *A. montana*, *A. elachista* var. *conferta*, *A. crassa*, *A. koordersi*, *A. banaresensis*, *Aphanothece pallida*, *A. bullosa*, *A. naegelii*, *A. stagnina*, *Merismopedia tenuissima*, *M. convoluta*, *Synechocystis aquatilis*, *Myxosarcina spectabilis*

Pseudoparenchymatous forms: *Hydrococcus rivularis*

Non-heterocystous filamentous forms: *Microcoleus chthonoplastes*, *Schizothrix vaginata*, *S. friesii*, *Spirulina laxissima*, *S. major*, *Phormidium purpurascens*, *P. ambiguum*, *P. rotheanum* var. *capitatum*, *P. subfuscum*, *P. calcicola*, *P. fragile*, *P. corium*, *P. anomala*, *Lyngbya majuscula*, *L. aestuarii*, *L. major*, *L. baculum*, *L. nordgardhii*, *L. arboricola*, *L. birgei*, *L. ceylanica* var. *constricta*, *L. rubida*, *L. martensiana* var. *minor*, *L. sordida*, *L. kashyapii*, *L. dendrobia* form *lurida*, *L. dendrobia* var. *skujaii*, *Oscillatoria tenuis*, *O. subbrevis*, *O. willei*, *O. laetevirens*, *O. salina*, *O. boryana*, *O. okeni*, *O. pseudogerminata*, *O. animalis*, *O. curviceps*, *O. terebriformis*, *O. foreaui*, *O. perornata* f. *attenuata*, *O. acuminata*, *O. fomosa*, *O. claricentrosa*

Heterocystous forms: *Cylindrospermum licheniforme*, *C. muscicola*, *C. gorakhpurense*, *Anabaena sphaerica* var. *attenuata*, *A. fertilissima*, *A. iyengarii*, *A. doliolum*, *A. ambigua*, *A. naviculoides*, *A. variabilis* var. *kashiensis* , *A. flos-aquae*, *A. oryzae*, *Nostoc spongiaeforme* var. *varians*, *N. piscinale* forma *Rao*, *N. linckia* var. *arvense*, *N. commune*, *N. ellipsosporum*, *N. punctiforme*, *Nodularia spumigena*, *Aulosira fertilissima*, *A. fertilissima* var. *tenuis*, *A. prolifica*, *Scytonema bohneri*, *S. pseudohofmanni*, *S. ocellatum* form *mino*, *S. guyanense* var. *prolifica*, *S. bewsii*, *Tolypothrix tenuis* , *T. distorta* var. *samoensis*, *Calothrix braunii*, *C. marchica* var. *intermedia*, *C. gardneri*, *Gloeotrichia natans*, *Fischerella muscicola*, *Hapalosiphon welwitschii* form *Rao*

RESULTS AND DISCUSSION

Out of total 576 samples collected from 11 sites, 504 contained cyanobacteria *i.e.*, 87.5%. From all the collected samples, 27 genera have been reported out of which 11 genera (*i.e.*, 40.74%) belonged to heterocystous category, followed by 9 genera (*i.e.*, 33.33%) of unicellular/colonial forms, 6 genera (*i.e.*, 22.23%) of non-heterocystous filamentous forms and only 1 genus (*i.e.*, 3.7%) of pseudoparenchymatous type.

Total 102 cyanobacterial forms belonging to 100 species of 27 genera were from 8 families of the order Chroococcales, Pleurocapsales, Nostocales and Stigonematales (Table 1). The Nostocales with 4 families constituted the highest number (74.5%) of forms. In totality, the non-heterocystous filamentous forms (43) were largest in number followed by heterocystous forms (35) (Fig. 2) (Anand *et al.*, 1990).

Amongst the 35 heterocystous forms with total relative abundance of 37.35%, genus *Aulosira* had highest relative abundance (*i.e.*, 14.39%) followed by *Anabaena* (*i.e.*, 8.66%) and *Nostoc* (*i.e.*, 5.35%) respectively. In this category, *Anabaena* with 9 species was the most diverse followed by *Nostoc* with 6 species and *Scytonema* with 5 species. In non-heterocystous filamentous category, *Oscillatoria* was the most diverse with 16 species followed by *Lyngbya* with 14 forms and *Phormidium* with 8 species. Among the unicellular/colonial forms, *Aphanocapsa* (7 species) was the most diverse followed by *Aphanothece* and *Chroococcus* with 4 species each.

Order Nostocales had the highest number of 76 forms of 15 genera followed by the Order Chroococcales with 22 species of 8 genera (Table 1).

Table 1: Taxonomic categorization of blue-green algae obtained from different rice cultivation sites around Varanasi.

Order and Family	Genera	Species	Forms
Chroococcales			
i.Chroococcaceae	8	22	22
Pleurocapsales			
i.Pleurocapsaceae	1	1	1
ii.Hyellaceae	1	1	1
Nostocales			
i.Oscillatoriaceae	6	42	43
ii.Nostocaceae	5	21	22
iii.Scytonemataceae	2	7	7
iv.Rivulariaceae	2	4	4
Stigonematales			
i.Stigonemataceae	2	2	2
Total :	27	100	102

In the sense of number of genera, family Chroococcaceae (Order Chroococcales) was the most diverse with 8 genera followed by Oscillatoriaceae with 6 genera and Nostocaceae with 5 genera (both are families of the Order Nostocales) (Table 1).

In terms of number of forms, family Oscillatoriaceae was the most diverse with 43 forms, followed by Nostocaceae and Chroococcaceae with 22 forms each.

In terms of relative abundance (RA), *Aulosira fertilissima* was most abundant with 7.11% RA followed by *Aulosira fertilissima* var. *tenuis* having 6.07% RA and *Gloeocapsa stegophila* var. *crass* as well as *Aphanothece pallida* with RA 3.47%. On comparing the diversity of heterocystous with all the non-heterocystous cyanobacteria, the former were less than the latter (Fig. 2) (Tiwari, 1972). However, the highest relative abundance (37.35%), throughout presence and the ultimate dominance during the last part of rice cultivation cycle reflected the highest tolerance and adaptability of heterocystous forms in comparison to other algal forms.

During the present study, it had been found that the majority of the genera of Cyanobacteria reported previously from the rice fields of Varanasi (Singh, 1939; Singh, 1978) had maintained their presence. In the present scenario of changing and disappearance of biodiversity of various organisms due to the increasing pollution load and other human interferences, Cyanobacteria still upto some extent maintained their diversity which shows their higher tolerance. However, the major difference observed in the diversity of Cyanobacteria was the preponderance of non-heterocystous filamentous forms especially the *Oscillatoria* spp.

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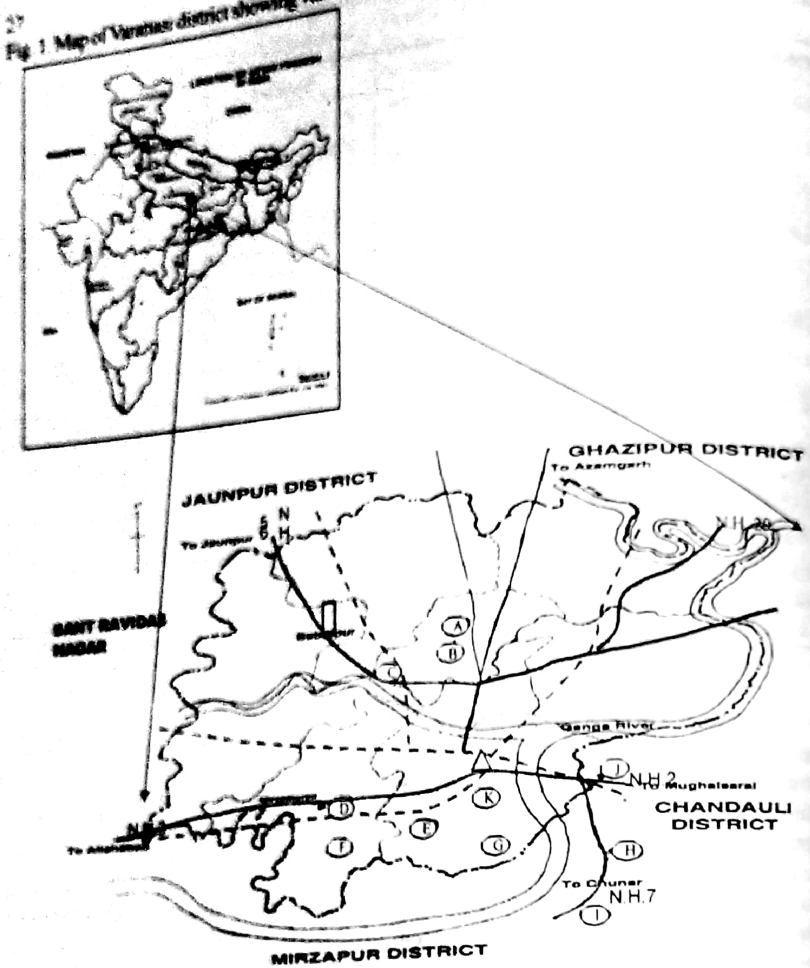
Fig. 1 Map of Varanasi district showing various sites of investigation



Δ - VARANASI CANT STATION
○ SITES OF INVESTIGAION
N.H. - NATIONAL HIGHWAY
▯ - AIR PORT

A- Aura Village
B- Murdaha Village
C- Harahua Village
D- Mirzamurad
E- Lathiya Village
F- Khanav Village
G- Narottampur
H- Kamalpur
I - Chunar
J - Bahadurpur-Madhiyao Village
K- Garden Cultivation

Fig. 2 Cyanobacterial forms collected from various sites

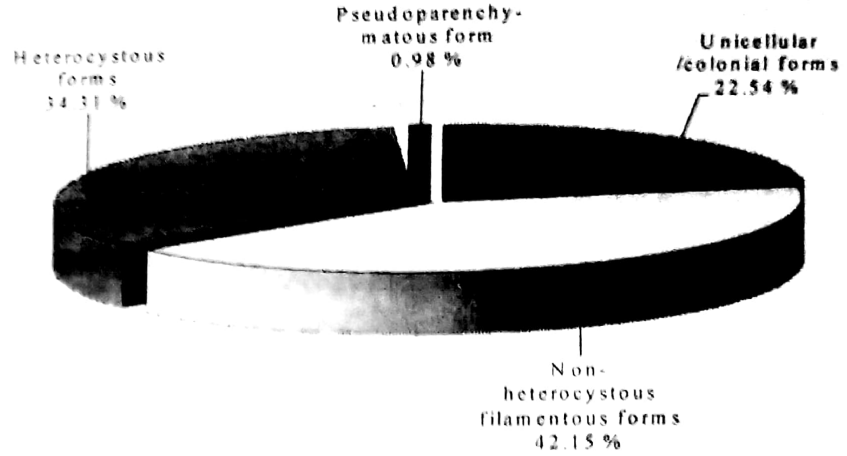
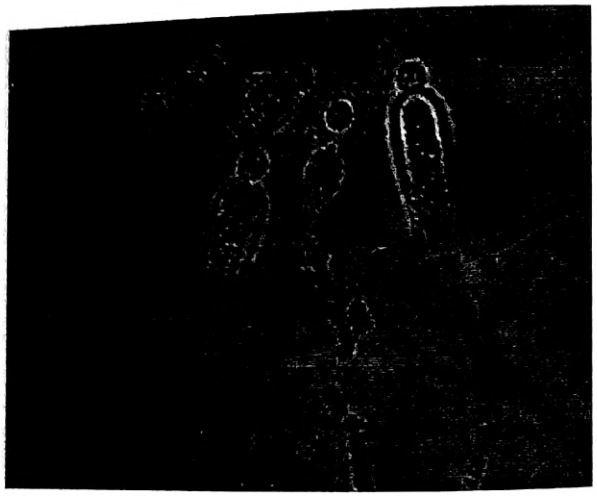


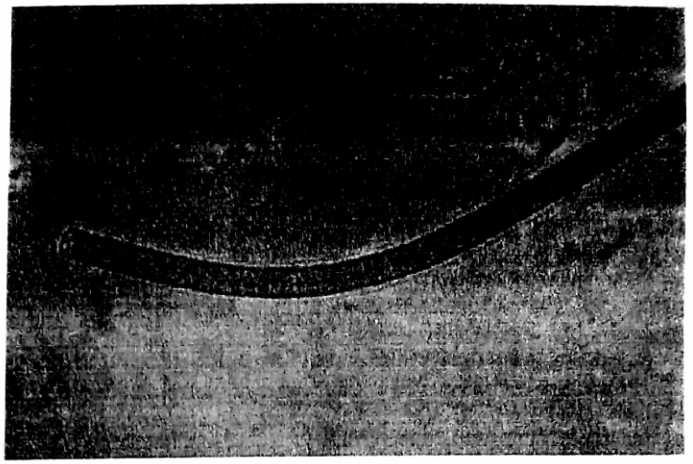
Fig. 3 Photograph showing the thick layer of *Aulosira fertilissima* entangled between the rice plants

Fig. 4. Microscopic photograph of (a) large number of filaments of *Aulosira fertilissima* with their heterocyst (b) filaments of *Gloeotrichia natans* (c) single filament of *Phormidium rotheanum* var. *capitatum* (d) cells of *Aphanothece stagnina*

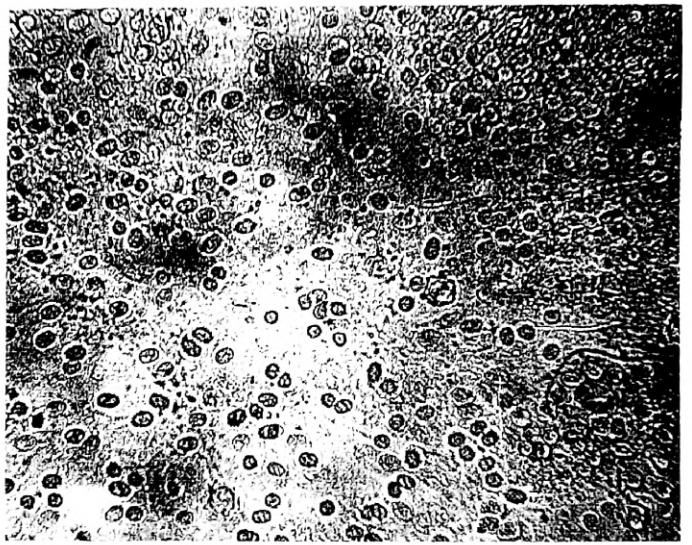
(a)



(b)



(c)



(d)

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Journal of Natural Resource and Development 2(1):32-37, 2007

COMPOSITE FISH CULTURE IN DISTRICT FAIZABAD : SOCIO-PERSONAL, ECONOMIC AND CULTURAL CONSTRAINTS AMONG FISH FARMERS

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ABSTRACT

A survey was conducted to asses the socio-personal, economic and cultural constraints of composite fish culture among fish farmers in Faizabad district. Three of all eleven blocks in Faizabad district were selected for the study; the block were further categorized on their high, medium and low fish production. Four villages from each block were selected randomly. By using a method of face-to-face direct interview, on pretested questionnaire of fish farmer, the data was put to analysis. A simple method of average and percentage was used as the tool. The result, thus, obtained showed that the composite fish culture yield was much below the potential yield in the district.

Key Words : *Socio-economic status, composite fish culture, constraints.*

Aquaculture in India is almost synonymous to carps culture, since the latter alone contributes to more than 80% of total aquaculture production of the country (I.C.A.R., 2006). India has played a great role in evolving and popularizing the technology of Indian major carp and exotic carp culture together termed as 'Composite fish culture' to augment fish production from pond. This technology is feasible and economically viable throughout the country without any agroclimatic restriction.

The total production of fish in India is 6.3 million tones in which 2.8 million tones comes from marine sector and 3.5 million tones from Inland sector. The average yield of Uattar Pradesh is 2550 kg/ha which is much below the potential (Ayyapan and Venkateshwarlu, 2002).

In composite fish culture more than 10 tones/ha is achieved through recent technology. The average production of Faizabad district is 1,067 kg/ha (FFDA, 2003), which is very low. For this reasons it is essential to find out the existing level of socio- personal, economic, cultural and constraints of composite culture fish farmers (Thomas, 1984).

Keeping in view these issues, the present study was undertaken with objectives : (1) To study the socio-personal, economic and technological aspects of composite fish culture and (2) To study the constraints responsible for low fish production.

MATERIALS AND METHODS

The study was conducted in Faizabad district which falls under the jurisdiction of Narendra Deva University of Agriculture and Technology, Kumarganj, Faizabad (U.P). In this district there are 11 blocks, in which 3 blocks namely; Mayabajar, Msaudha and Milkipur are classified as high, medium and low fish production (FFDA, 2003). A total of 12 villages (four villages randomly selected) from above three block and from these villages 30 fish farmers were selected for the study. Face-to-face interviews were conducted with pretested questionnaires. The main focus was on the socio-personal and economic background of selected fish farmers, culture technique used and problems faced by them in composite fish culture.

RESULTS AND DISCUSSION

A). SOCIO-PERSONAL: The socio-personal level of the fish farmers.

1). **Age** : The highest number of respondents (63.33%) were observed in the age group of 31-45

years whereas 26.67 percent fall in the age group of above 45 years and upto 60 years of age there were 10 percent.

2). **Education:** Almost 83.33 percent of the respondents were literate. Among literate the literacy was found in decreasing order *i.e.* High school 20%, Intermediate 10%, Graduate 10%, Postgraduate 3.33%. Primary and can read and write 23.33% and 16.66% respectively. The illiterate respondents were 16.66%.

3). **Caste**: Majority of fish farmers 43.33% were belonging to General caste followed by Backward caste 36.67% and Scheduled caste 20%. Hence General caste was dominant as far as participation in fish farming.

4). **Family Size**: Little less than half 46.66% respondents were observed such who had 6-10 members in their family and 36.67% respondents had above 10 members in their family.Only16.67% respondents were found having upto 5 members in their family.

5). **Housing Pattern**: Majority of respondents have mixed 46.67% house. Hut, kuccha and pucca were found 16.66% ,10% and 26.67%, respectively.

6). **Mass Media Exposure**: Majority of respondents use Radio (only) 30% followed by Radio, T.V. (both) 26.67%, Radio, Newspaper (both) 23.33%, T.V., Newspaper (both) 10%, T.V. (Only) 6.67% and Radio, T.V, Newspaper (all) 3.33%. It was concluded that Radio was the media used as main source of information.

B). **ECONOMIC ASPECT**: The economic aspects of the fish farmers.

1. **Land Holding:** The highest numbers of respondents 53.33% belonged to the category of below 1 ha followed by 1-2 ha (26.67) and above 2 ha (10%) respondents. Only 10% farmers were landless.

2. **Occupation :** The majority (50%) of respondents have adopted fish farming as main occupation and as subsidiary occupation (50%) only. Agriculture farmer 40% as main occupation and subsidiary 23.33% occupation of the respondents, like-wise labouer as main occupation 6.67% and subsidiary 16.67%. The percentage of service (Government and Private) as main occupation 3.33% and subsidiary 10%. Over all it was observed that fish farming was main occupation of majority 50% and also fish farming as subsidiary occupation 50%.

3. **Pond Ownership :** 86.67% respondents having leased ponds while remaining 13.33% have their own ponds. Thus it is concluded that the majority of fish farmers 86.67% have leased ponds.

4. **Pond Size** : The pond size of majority of respondents 83.33% was below 1ha, followed by 16.67 percent 1–2 ha and 0% above 2 ha. Over all it was observed that the area of pond of maximum respondents were less than 1 ha.

5. Annual Income : 53.33% respondents were those whose family annual income was of Rs 20,000–40,000 followed by 20% (Rs 40,000–60,000), 10%(Rs 60,000 – 80,000), 6.67% (Rs. upto-20,000), 6.67%(Rs 80,000–100000) and 3.33% were found in more than 1 lakh. The average annual income was found to be Rs. 43,000.

C). **CULTURE TECHNOLOGY:** The data depicted in the Table1 indicate the knowledge of fish farmer about culture technologies.

1). Experience of Composite Fish Culture : The majority of respondents 43.33% adopted composite fish culture technique since 5 years and 43.33% fish farmers have adopted since 6–10 years followed by above 10 years (13.33%).

2). Training Gained : 50 Per cent respondents were trained and 50% were untrained.

3). Pond Type : More than half of the respondents (66.67%) have unmanaged type pond whereas 33.33 per cent are managed pond.

4). Culture Type : The majority of respondents were adopted extensive culture (traditional type) 66.67 % and semi–intensive culture only 33.33 % . It shows that the fish farmers adopted traditional type of culture of fishes.

5). Water Resources : Majority of respondents (76.67%) possessed electric tube wells. Thus it is concluded that tube wells (76.67%) used even today

Table. 1. Details of socio-personal, economic and cultural technology aspects of fish formers of Faizabad

Variables	No. of respondent	Percentage
1. Experiences of composite fish culture		
Upto–5 years	13	43.33
6–10 years	13	43.33
Above 10 years	4	13.33
Total	30	100
2. Training gained		
Trained	15	50.00
Untrained	15	50.00
Total	30	100
3. Water level		
Upto–1 meter	6	20.00
1–2 meter	19	63.33
Above 2 meter	5	16.67
Total	30	100
4. Manuring and Fertilization		
A)Type: Organic manure (O.M)	13	43.33
O.M. + Inorganic fertilizers	16	53.33
Without manure and fertilizers	1	3.33
Total	30	100
B) Frequency: Monthly	-	-
Third-monthly	5	16.67
Half-yearly	5	16.67
Yearly	20	66.66
Total	30	100
5. Liming of the pond /ha		
Below 100 kg	18	60.00
100 – 200 kg	5	16.67
Above 200 kg	-	-
No application of lime	7	23.33
Total	30	100
6. Fish Species Combination		
2 species	4	13.33
3 species	9	30.00
4 species	6	20.00
5 species	-	-
6 species	11	36.67
Total	30	100

7. Stoching Density /ha	-	-
5000-6000	10	33.33
6000–10,000	15	50.00
10,000–20,000	5	16.67
Above 20,000	30	100
Total		
8.A) Feed ingredients Supplementary Feed	6	20.00
Rice Bran (R.B.) alone	24	80.00
R.B.+Mustard oil-cake (M.O.C)	-	-
R.B.+M.O.C+Others	-	-
R.B.+Others	30	100
Total		
B) Feeding Quantity /ha	-	-
100 kg/year	3	10.00
200–500 kg/year	-	-
500–1000 kg/year	27	90.00
No idea	30	100
Total		
C) Feeding Frequency	7	23.33
Daily	3	10.00
Twice in a week	10	33.33
Weekly	6	20.00
Fortnightly	4	13.33
Monthly	30	100
Total		
9. Harvesting	-	-
Within 6 months	7	23.33
6–8 months	20	66.67
8–10 months	3	10.00
10–12 months	30	100
Total		
10. Yield (kg/ha) according to Fish Species	**Average field (kg/ha)**	
2 species	1173.46	
3 species	2204.44	
4 species	2879.7	
5 species	-	
6 species	2507.41	
Total	8765.01	
Average	2191.25	

as main source for water filling in ponds by majority of fish farmers.

6). **Water Level** : The highest number of respondents (63.33%) were maintaining 1-2 meter level of water in ponds. Remaining above 2 meter (16.67%) and below 1 meter (20.00%) . Thus it was concluded that the majority of respondents keep 1-2 meter water level in their ponds.

7). **Measuring and Fertilization :** Majority of fish farmers (53.33%) use organic manure + inorganic fertilizer but (0%) used monthly. Only organic manure was used by (43.33%) respondents.

8). **Fish Species Combination :** Fish farmer stocked their ponds with a combination of Indian Major Carp (IMC) and Exotic carps (EC) fry/fingerlings. The majority of respondents 36.67% stocked 6 species, 3(IMC) and 3(EC) (30%) followed by 3 species 3(IMC) 30%, 4 species 3(IMC) and 1(EC) 20% and 2 species 1 (IMC or EC)-13.33%, respectively.

9). **Stocking Density/ha**: Majority of respondents (50%) stocked 10,000 to 20,000 fry/ha followed by 6000 to 10,000 fry/ha (33.33%) and above 20,000 fry/ ha (16.66%), respectively.

10). **Feed Ingredients, Frequency and Quantity :** Majority of respondents used rice bran (RB) and mustard oil cake (MOC) (80%) with a feeding frequency of weekly (33.33%) and no idea about feeding quantity (90%).

11). **Yield :** The highest yield was obtained from the fish farming in 4 species combination 2879.7 kg/ha/yr followed by 6 species combination 2507.41 kg/ha/ yr. The average yield of Faizabad was 2191.25 kg/ ha/yr.

D). **Constraints :** The respondents were asked to report the constraints they faced in adoption of recommended technologies causing technological gap in their fish farming. During the investigation the respondents expressed variety of constraints which were grouped into three categories *viz*, technological, information transfer and socio-economic constraints and are presented in Table 2.

In this study it is concluded that education level of the fish farmer was very low. The maximum per cent of 31–45 years age group of farmers was related with this occupation. General caste was dominated over other caste. There is no perfect media for

Table 2 : Constraints faced by the fish formers of Faizabad

S.No	Technological Constraints	(n=30)	Percentage	Rank
1.	Lack of facility for soil and water testing	25	83.33	1st
2.	Weed fish in pond	22	73.33	2nd
3.	Aquatic weed	19	63.33	3rd
4.	Algal blooms	14	46.67	4th
5.	Lack of assured water supply	13	43.33	5th
6.	Non availability of good quality and quantity of fish seed	7	23.33	6th
7.	Lack of balance feed of fish (pellets)	2	6.67	8th
8.	Disease of fish	3	10	7th

S.No.	Information Transfer Constraints	(n = 30)	Percentage	Rank
1.	Lack of knowledge about information center	23	76.67	2nd
2.	Lack of technical knowledge	27	90	1st
3.	Lack of technical guidance	10	33.33	3rd
S.No.	**Socio-Economic Constraints**	**(n=30)**	**Percentage**	**Rank**
1.	Lack of inputs	23	76.67	2nd
2.	Low price of fish	30	100	1st
3.	Lack of fish insurance	10	33.33	4th
4.	Lack of transport facility	19	63.33	3rd
5.	Fish poaching	5	16.66	5th

technology transfer in socio-personal study (Saharan, 1992).

In economic aspect majority of respondent have below 1 ha agricultural landpond area. Maximum pond are in leased pattern. The occupation of the respondents was double, only 50% respondents have fish farming as main occupation. The annual income of majority of respondents ranges from Rupees 20,000 to 40,000 was very low.

The technologies of composite fish culture are not fully adopted by the fish farmer (Sen, 1987). Only 30–40% technology was adopted by the fish farmer which shows a big technological gap. It is calculated by the production (2,191 kg/ha) of fish by the fish farmer and production (6,000–8,000 kg/ha) of fish by research institute/FFDA. Constraints are also responsible for low production like unorganized marketing channel which resulted in low price of fish, lack of technical knowledge, lack of facility for soil and water testing *etc.*.

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Journal of Natural Resource and Development 2(1):38-44, 2007

LENGTH-WEIGHT RELATIONSHIP AND CONDITION FACTOR OF *LABEO CALBASU* (HAMILTON) FROM GUPTARGHAT OF THE GHAGHARA RIVER

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ABSTRACT

Length-weight relationship of *Labeo calbasu* was estimated from Guptarghat of Ghaghara river during December, 2003 to March, 2005. Regression coefficient and correlation coefficient were higher in male (3.0561 and 0.9602) than female (3.00497 and 0.909) of the species. ANCOVA showed that no significant difference between 'b' among the sexes of the fish. Fluctuation in the condition factor have been found in the both sexes of this species. K value was highly effected by gonadal maturation than feeding.

Key words : *Condition factor, length–weight relationship, Labeo calbasu.*

Knowledge on the length weight relationship of fish has vital importance in fisheries science for population dynamics as it not only helps to establish the mathematical relationship between the two variables the length and weight. But also to convert one variable in to the other (Kulbicki *et al.*, 1990). *Labeo calbasu* is a medium sized bottom feeding fish which generally attains length of 90 cm and weight of 5.5kg. (Alam *et al.*, 2000). It is a commercially important species of the Indo-Pak-Bangladesh subcontinent. There is a large literature on length weight relationship and condition factor of this species available in south India (Jhingran, 1957; Khan and Siddique, 1973; Sree Prakash and Gupta, 1986). This contribution aims at filling an obvious information gap for Cyprideae family *L.calbasu* from the Ghaghara river.

The condition factor (K) reflects, through its variations, information on the physiological state of the fish in relation to its welfare. From a nutritional point of view, there is accumulation of fat and gonadal development (Le Cren, 1951). From a reproductive point of view, the highest K values are reached in some species (Angelescu *et al.*, 1958., Thakur, 1975). Condition factor also gives information when comparing two populations living in certain feeding, density, climate, and other conditions; when determining the period of gonadal maturation; and when following up the degree of feeding activity of a species to verify whether it is making good use of its feeding resources (Weatherley, 1972; Ricker, 1975). Hile (1936) also provide a useful comparison of the weight of individual fish relative to length.

MATERIALS AND METHODS

The material for the Present study consisting of 195 specimen ranging from 163 mm to 574 mm in total length and 50 to 2600 g in total weight including 98 females range from 154 to 574 mm in length and 50 to 2700 g in weight and 90 males specimen from 160 to 545 mm in length and 55 to 2800g in weight were regular collection from Guptarghat of Ghaghara river in Faizabad for a period of December, 2003 to March, 2005. The total length of the fish was taken nearest mm (from the tip of the snout to the tip of the largest caudal ray) and weight of each fish was taken separately to the nearest gram.

The length-weight relationship was calculated by the least square method for male and female separately by using the parabolic equation W=a Lb or its logarithmic form

Log W=log a+b logL

where W=weight in grammes; L=length of fish in millimeters; a=constant; b=regression coefficient.

Analysis of covariance (ANCOVA) was carried out to determine statistical difference in the length-weight relationship of male and female of the species (Snedecor and Cocharan, 1967).

Length-wise condition factors of the individually the sexes of *L. calbasu* was determined by using the expression:

$$K=100000*W/L^b$$

Where 'W' is weight in grammes, 'L' is length in millimeters and 'b' is exponent of the length-weight relationship.

RESULTS AND DISCUSSION

Length and weight of a particular species of fish are closely related to each other (Le Cren, 1951). Therefore, a mathematical representation of length-weight relationship from a study of number of specimens of different sizes can be derived. The length-weight relationship of a stock from a particular area of a fish is a useful tool for the study of population dynamics. In addition, it also gives an idea about the general condition of the population.

It is known that with increase in the length of fish, the weight also increases, but in more rapid way, thereby showing that the weight of fish is a function of length. Since length is a linear measure and the weight is a measure of volume, it takes a cube form. Hence, a cube law generally expresses length-weight relationship.

The length-weight relationship and correlation coefficient (r) obtained for the two sexes separately and the combined relationship for the two sexes together were logarithmic transformation (Fig. 1-3).

Male: Log W= - 4.9921 + 3.0561 log L.....1

r= 0.9602

Female : Log W= - 4.8832 + 3.00497 log L.....2

r= 0.909

Combined : Log W= - 4.933 + 3.0256 log L.....3

r=0.9243

The regression coefficient (b) indicates that weight of fish increased more or less in proportion to the cube to its length but the male grow faster by weight than female as their exponential value were more (Table1). However, ANCOVA showed that there was no significant difference between 'b' among the sexes of the fish of the species (Table 2).

The value of 'b' is generally 3 and may vary between 2.5 and 4.0. The value of 'b' closed to 3 indicates that the fish grow systematically or isometrically provided its specific gravity remain constant. However, in many cases the cube law is apparently not obeyed as the fishes change slope during growth. Under these circumstances, values other then 3 indicates allometric growth.

The length-weight relationship of *L. calbasu* in Bangladesh water for the two sexes together have been reported by several researcher. Alam *et al.* (2000) reported as Log W= - 2.0330 + 3.109 log L (r= 0.992) and Yousuf *et al.* (2002) observed exponent 'b' value for *L. calbasu* >3.0. Both authors found that exponential 'b' more than 3 indicating allowmetric growth of this species. In the present study, 'b' separately for 3.0531, 3.00497 and 3.0256 male, female and pooled respectively are shown allowmetric growth in Guptarghat of Ghaghara river.

The condition factor values obtained for different size groups of males and females of *L. calbasu*. It is seen that for the males showed an inversed relationship with length. Smaller fishes had higher condition values while bigger fishes had smaller values may be due to higher metabolism. K values were maximum in the size group 150-190 mm and again in 431-470 mm, the values were minimum in 311-350 to 351-390 mm groups. *Brycinus nurse* also showed similar result from Asa Reservoir, Nigeria.

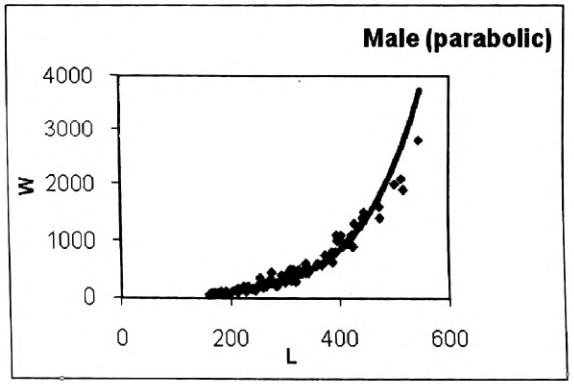
Table 1: b and r value of male female and pooled

Sex	a	b	r
Male	-4.99924	3.053158	0.981177
Female	-4.88324	3.004976	0.982938
Pooled	-4.933	3.0256	0.982333

Table 2: Analysis of covariance of *L. calbasu*

d.f.	ex2	ey2	exy2	df	ey2-(exy2)2/ex2
100	1077505	36562229	5666175	99	6766043.2
91	848681.9	25894268	4326370	90	3839505.9
				189	10605549.1
191	99931054	62672969	10036453	191	61664970.1
				2	51059421
df	ss		ms		f
2	51059421		25529711		454.9613829
189	10605549.1		56114.02		

Fig. 1: Length-weigth relationship in the male *L. calbabu*



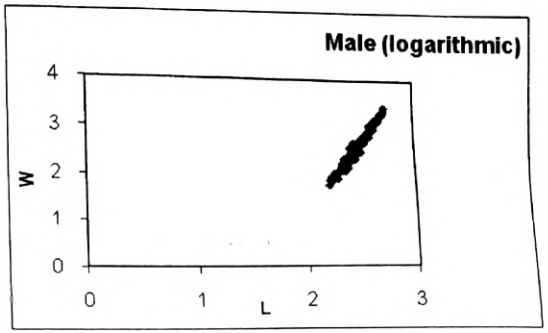
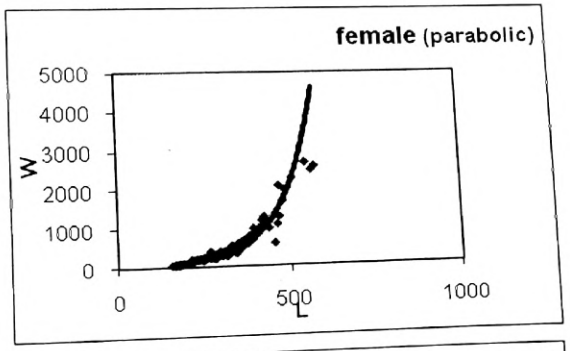


Fig. 2: Length weigth relationship in the female *L. calbabu*



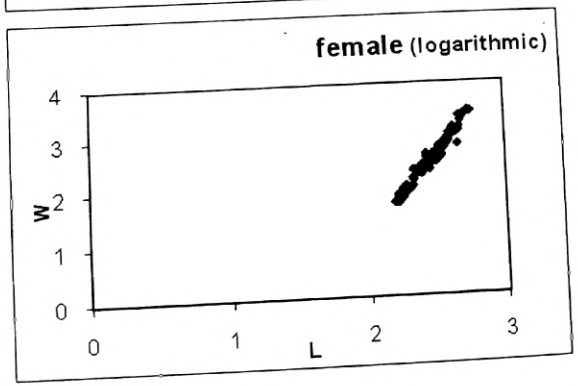


Fig. 3 : Length wise condition factor in male *L. calbasu*

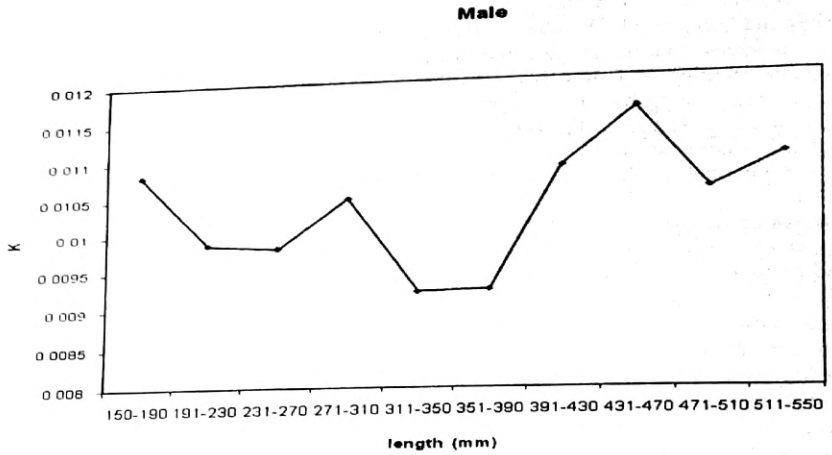
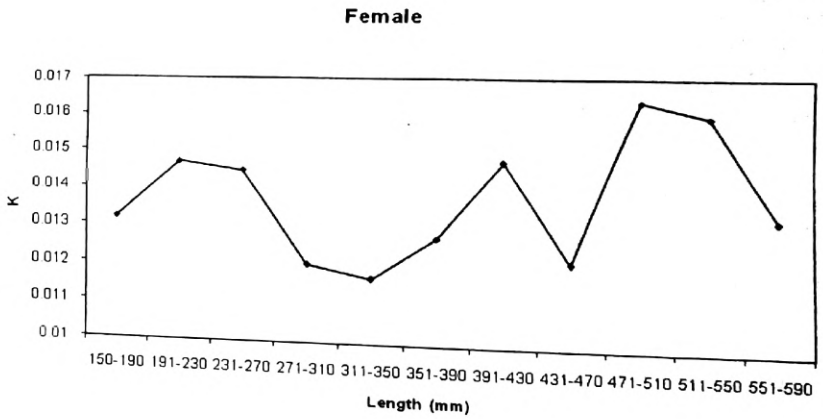


Fig. 4 : Length wise condition factor in female *L. calbasu*



(Saliu, 2001). For the females of *L. calbasu* the sharp increase in K value was noticed 190-230 to 231-290 and 471-510 to 511-550 mm size.

The condition factor is an index reflecting interactions between biotic and abiotic factors in the physiological condition of fishes. It shows the population's welfare during the various stages of the life cycle (Angelescu *et al.*, 1958). Kangur *et al.* (2003) stated that condition factor of fishes are better reflected with environment than in its linear growth rate.

The sharp rise in K, 431-470 mm size group in male and 471-510 to 511-550 mm size group particularly in the case of females, appears to be due to gonadal maturation as the ovaries attain larger size and weight. The high K of 150-190 mm in male and 190-230 to 231-290 mm in the female were attributed due to feeding intensity. But no noticeable fluctuation was recorded in condition factor through season-wise in both sexes of *L. calbasu*.

The value of 'b' for male 3.0561 was higher than 3.0049 female which mean that the increase in per unit weight for unit increase length in greater in male. It is reason that male 470 mm begins to mature earlier than female 530 mm. Higher rate of increase in weight is related to higher level of nutrition which would be evident from size related analysis of condition factor. This parameter would tell that in which stage of life the weight gain is due to food and or to growth of gonads. A well-fed fish will thus race to sexual maturity. The condition of young is stated to be influenced by the diet or feeding intensity and that of adult by gonads, (Gupta, 1967). The linear growth by length is most rapid in immature fish while largest weight gain occur for mature fish due to maturity and feeding intensity (Nikolsky 1963). The study of length weight relationship indicate that male was a fast growing fish compared to female. Correlation coefficient was also relatively higher in male that female in *Labeo calbasu*.

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Journal of Natural Resource and Development 2(1):45-48, 2007

SOCIO-ECONOMIC STATUS OF DAIRY FARMERS IN TRANS-YAMUNA AREA OF ALLAHABAD DISTRICT

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ABSTRACT

A study on socio-economic status on 200 dairy farmers comprising twenty each from ten villages of five development blocks in Trans-Yamuna area was conducted. The study revealed that 41 percent respondents were above 38 years of age, 25 percent were educated up to primary level and 49.5 percent families were mainly dependent on crop farming along with dairying. Respondents who utilized their land for fodder production in Rabi and Kharif season were 43.75 and 31.88 percent respectively The respondents maintained 1-2 milch cattle and buffaloes. Herd size increased with the increase in land holding.

Key words : Socio - economic status, dairy farmers, trans-Yamuna, Allahabad

Livestock is a natural resource with tremendous potential to provide self-employment, increase income and nutritional security to millions of household in rural areas. It contributes approximately 25.5% towards income from the agricultural sector. A common phrase "A land rich in livestock can never be poor and a land poor in livestock can never be rich" emphasizes the importance of livestock in our day-to-day life. Cattle maintained by all the sections of the society irrespective of their caste and income levels. occupies a unique position in our national economy.

The livestock rearing is an integral component of the economy and inseparable from the agricultural component of almost every household in rural areas, due to small size of holding. Allahabad being one of the leading districts of Uttar Pradesh plays a key role in dairy activities. As per the cattle census of 1993, Allahabad has around 110907 crossbred cattle, 841109 indigenous cattle and 459319 buffaloes. Total livestock population in the year 1997 was 1564738 with 46 veterinary hospitals and 88 Livestock service centres.

MATERIALS AND METHOD

Five development blocks of trans-Yamuna area namely Chaka, Jasra, Karchhana, Kaundhiara and Shankergarh of Allahabad district of Uttar Pradesh were purposely chosen for the present study. Twenty households from each village and two villages from each Block comprising of different socio-economic strata *i.e.* Landless, Marginal, Small, Medium and Large Farmers were chosen randomly and thus 200 respondents were selected for the collection of needed data. Multistage stratified random sampling technique was adopted for selection of sample household. The socio-economic strata was decided on the basis of cultivable land holdings as follows:

Landless farmers : having no cultivable land

Marginal Farmers : having land holding up to 2.5 acre (1.0 ha)

Small Farmers : having land holding from 2.51 to 5.00 acre (1.1 to 2.0 ha)

Medium Farmers : having land holding from 5.1 to 15.0 acre (2.1 to 6.0 ha)

Large Farmers : having land holding above 15.0 acre (6.0 ha)

The required information were collected from respondents by using a specially developed questionnaire and schedule and analyzed statistically.

RESULTS AND DISCUSSION

The data regarding age, educational status, main occupation of the dairy farmers and area under fodder crops are presented in Table 1.

Profile of dairy farmers

Overall 41 percent respondents were above 38 years of age, followed by 33 percent in age group of 28-38 years, 18.5 percent of 18-28 years age and below 7.5 percent of 18 years age, respectively. Verma (1989) reported that most of the bovine keepers were in the age group of above 30 years in adopted village of Hissar. Panwar (1992) reported that majority of the respondents (41.75%) were above 38 years of age and only 6.19 percent of less than 18 years of age in Karnal district.

Educational status

It is evident from the table that among the respondents of study area majority (25%) of them were literate up to primary level, followed by illiterates (23%), middle (21 %), matric (19%), graduate (9.5%) and post-graduate (2.5%). Contrary to the results of present study Verma (1989) reported 35 percent illiterate farmers and Panwar (1992) reported 60.31 percent illiterates in their study areas, respectively. The variation between the studies might be due to difference in village and target groups of the study area.

Main occupation

Regarding the occupation of the respondents, 49.50 percent households were mainly engaged in crop farming plus dairying. About 85 percent of the landless respondents were engaged in casual labour plus dairying. Similarly 75 percent medium farmers followed by 66.67 percent large, 65.0 percent small, 43.18 percent marginal farmers were found engaged in crop farming along with dairying. Verma (1989) reported 87.50 percent respondents and Panwar (1992) reported 64.95 percent of household were dependent on crop farming plus dairying in their study areas respectively, which is contrary to the results of the present study and this could be ascribed to the differences in literacy among respondents of the study area.

Area under fodder crops

It is evident that majority (43.75%) of the farmers in Rabi and 31.88 percent in Kharif utilized 5.1 to 10.0 percent of their land under fodder production for their livestock and were aware of the importance of green fodder feeding to their animals. Panwar (1992) reported that 34 42 and 40.25 percent respondents utilized 10.10–20.0 percent of their land for Rabi and Kharif fodder production respectively, which is contrary to the results of present finding and this could be ascribed to the differences in study area and availability of resources.

Herd strength

The average number of dairy animals comprising of adults and young one was 12.34 per household, all the respondents of the study area maintained 1-2 milch cattle and buffaloes. Panwar (1992) reported average herd size of 6.25 for landless, 26.0 per household for large farmers and overall herd size of 14.37 per household in his study area, which is contrary to the present findings.

It was concluded that age and level of education mould the farmers response to improve the technology and market performance, because enlightened farmers relatively have higher motivation to diversify farm business and sell milk to earn more. This is especially true to dairy farming which requires a better quality of management and skill input than conventional crop farming. The farmers of the study area were aware about the importance of green fodder feeding to their livestock. The average herd size increased with the increase in land holding probably due to sound economic condition. availability of resources, land and awareness about dairying.

Table 1. Category-wise age, educational status, occupation of the respondents and land area under fodder crops in rabi and kharif season.

Particulars	Landless farmer n=40	Marginal farmer n=44	Small farmer n=40	Medium farmer n=40	Large farmer n=36	Total n=200
(i) Age group						
<18 years	-	4 (9.10)	4 (10.00)	5 (12.50)	2 (5.56)	15 (7.50)
18-28 years	6 (15.00)	12 (27.27)	10 (25.00)	5 (12.50)	4 (11.11)	37 (18.50)
28-38 years	10 (25.00)	18 (40.91)	16 (40.00)	10 (25.00)	12 (33.33)	66 (33.00)
> 38 years	24 (60.00)	10 (22.72)	10 (25.00)	20 (50.00)	18 (50.00)	82 (41.00)
(ii) Educational status						
Illiterate	22 (55.00)	11 (25.00)	5 (12.50)	4 (10.00)	4 (11.11)	46 (23.00)
Primary	7 (17.50)	20 (45.46)	7 (17.50)	10 (25.00)	6 (16.67)	50 (25.00)
Middle	6 (15.00)	8 (18.18)	10 (25.00)	8 (20.00)	10 (27.78)	42 (21.00)
Matric	5 (12.50)	5 (11.36)	10 (25.00)	10 (25.00)	8 (22.22)	38 (19.00)
Graduate	-	-	8 (20.00)	6 (15.00)	5 (13.89)	19 (9.50)
Post-graduate	-	-	-	2 (05.00)	3 (08.33)	05 (2.50)
(iii) Occupations						
Crop farming (CF)	-	-	-	-	-	-
Crop farming+dairying (CFD)	-	19 (43.18)	26 (65.00)	30 (75.00)	24 (66.67)	99 (49.50)
Casual labour+ dairying (CLD)	34 (85.0)	-	-	-	-	34 (17.00)
Crop farming+C.labour +dairying (CFCLD	6 (15.00)	11 (25.00)	4 (10.00)	2 (5.00)	-	23 (11.50)
Crop farming + dairying+service(CFDS)	-	14 (31.82)	10 (25.00)	8 (20.00)	12 (33.33)	44 (22.00)
(iv) Percent of their land area under fodder in Rabi and Kharif seasons						
Rabi <5%	-	14 (31.82)	20 (50.00)	8 (20.00)	8 (22.22)	50 (31.25)
Kharif	-	14 (31.82)	18 (45.00)	16 (40.00)	13 (36.11)	61 (38.12)
Rabi 5.1-10%	-	20 (45.46)	14 (35.00)	20 (50.00)	16 (44.45)	70 (43.75)
Kharif	-	12 (27.27)	10 (25.00)	15 (37.50)	14 (38.89)	51 (31.88)
Rabi 10.1-20%	-	10 (22.72)	4 (10.00)	7 (17.50)	8 (22.22)	29 (18.12)
Kharif	-	11 (25.00)	8 (20.00)	6 (15.00)	7 (19.44)	32 (20.00)
Rabi >20%	-	-	2 (05.00)	5 (12.50)	4 (11.11)	11 (6.88)
Kharif	-	7 (15.91)	4 (10.00)	3 (7.50)	2 (5.56)	16 (10.00)

Figure in parenthesis denotes percentage values.

ACKNOWLEDGEMENT

The authors are thankful to the family members of the respondents who helped in providing the necessary information for this study.

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Journal of Natural Resource and Development 2(1):49-54, 2007

AGE STRUCTURE AND GROWTH OF *LABEO CALBASU* (HAMILTON) FROM THE GHAGHARA RIVER IN FAIZABAD REGION (U.P.)

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ABSTRACT

***Labeo calbasu* (Hamilton) is commercially exploited in the Ghaghara river. Age structure and growth *of Labeo calbasu* of the river Ghaghara was determined by the key scale studies. Ghaghara is a left bank tributary of the Ganga. The study of the marginal rings on the scales of *L. calbasu* indicated their annual nature. Scales are generally preferred to other hard parts because of their easy availability. The fish attained 18.9, 27.8, 35.7, 41.8, 46.9, 54.9 and 57.4 cm at the end of I, II, III, IV, V, VI and VII years of life, respectively. The maximum growth was attained during the early years of life, subsequently the growth was slow. II year age group was maximum 33.68% in the exploited population. The age groups 1+ to 4+ constituted 91.17% of the total population and small proportion of remaining age groups (5+ to 7+). Age structure show heavy bottom pyramid.**

Key words *: Age structure, growth, Labeo calbasu, exploitation, Ghaghara.*

Labeo calbasu commonly known as Kalbasu is widey distributed throughout India, Pakistan, Bangladesh, Burma and Nepal. *L. calbasu* supports an important commercial fishery in rivers and reservoirs, lakes and even in ponds. It is a bottom feeder in habit (Pathak, 1975). It is common in the commercial catches of rivers like Narmada, Godavari, Yamuna and Ganga (Chondar, 1999). In Allahabad region it constituted 14.2% of the commercial catch (Singh et.al., 1998). Various workers had studied the length-weight relationship, condition factor, food and feeding habit and population dynamics of *L. calbasu* (Natarajan, 1971; Singh, 1999 and Alam, *et al.*, 2000).

Age structure of a population represents the ratio of the various age classes in a population to each other at a given time. It is bound to vary in exploited and unexploited population growth is the change in size (length, weight) over time. This is one of the most intensively studied aspect of fishery biology. The utility of hard structures to evaluate age and growth in various fish species has been examined by many workers (Jhingran, 1957; Kamal, 1969; Walfert and Miller, 1978; Rawat and Nautiyal, 1996; Johal *et al.*, 1996, 1999; Jepsen *et al.*, 1999; Bhatt *et al.*, 2000 Nautiyal and Negi 2004). However, studies on the age and growth of kalbasu are limited and fragmentary (Rao and Rao, 1972; Gupta and Jhingran, 1973; Tandon *et al.*, 1989 Singh, 1999). There is no published information on biology of L. calbasu from Ghaghara river. The fish populations from different locations varying in productivity and fishing pressure would have different length distributions, growth rates and age structure. Estimation of age structure and growth is essential for management and future policies for these valuable stocks.

MATERIALS AND METHODS

Experiment was conducted during 2003-05 at Guptarghat, Faizabad. Fish samples were collected from the commercial nets operated in the Ghaghara river (Gupatarghat Centre). Samples of scales from 193 specimens, total length ranging between 15.4 cm to 57.4 cm were examined for age and growth of the fish. The total length was measured from to tip of caudal fin to snout of the fish. Key scales were collected from the region just below the dorsal fin (3 to 4 rows) above the lateral line and were thoroughly

washed in tap water until all extra matter got completely removed and mounted intact in between two glass plates or slides. The annuli formation was determined according to the criterion suggested by Bagenal (1978) and adopted by Nautiyal (1990). Almost all the annuli, except the one, appeared as light relatively transparent bands, concentrically arranged round the whole of the anterior sculptured part of the scales. Age structure were determined on the basis of annuli and designated as 1+, 2+, 3+ and so on. A percentage frequency table was prepared on the basis of fish age and computed age structure in different years.

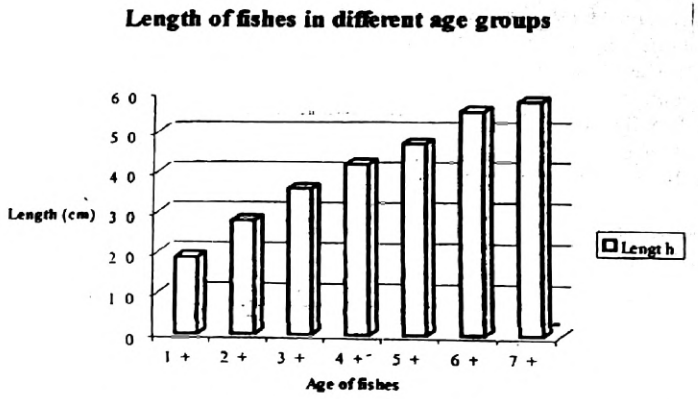
RESULTS AND DISCUSSION

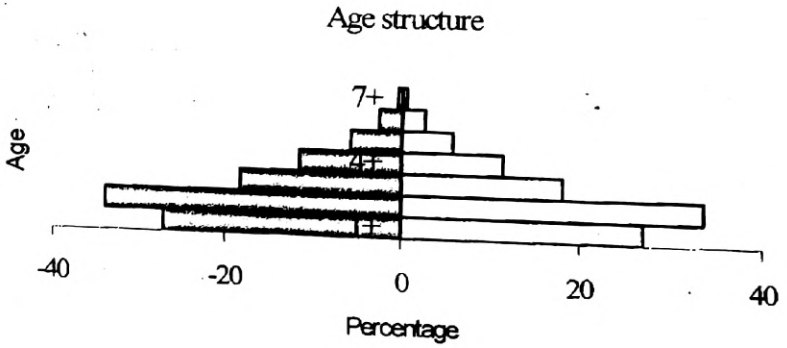
L. calbasu possesses cycloid scales. The anterior face is comparatively transparent, embedded in skin and posterior exposed face bears chromatophores. Scales are elongated and each has focus or nucleus which represents the origin of scale and becomes inconspicuous. An examination of scales revealed the presence of alternating fast and slow areas. A fast growth area (transparent zone) and a slow growth area (opaque zone) were together considered as an index of one-year growth ring. Each slow growth area consists of compactly packed continuous circuli preceded by a transparent zone which is represented by a number of comparatively widely spaced circuli. The distance between annuli decreases in fish of older age groups due to close spacing of annuli on the scales. Similar type of annuli have also been described by Jhingran (1959) in *Cirrhinus mrigala* from the river Ganga, Natarajan and Jhingran (1963) in *Catla catla* from river Yamuna, Kamal (1969) in *C. mrigala* from river Yamuna, Gupta and Jhingran (1973) in *L. calbasu* from the river Yamuna and Singh (1999) in *L. calbasu* from river Ganga and Yamuna, Allahabad region.

The samples collected during December 2003 to March 2005 were in 1+ to 7+ age groups, measuring 15.4 cm to 57.4 cm. The length ranges of the groups of *L. calbasu* which possessed scales with one, two, three, four, five, six and seven translucent zones, and therefore represented the 1+, 2+, 3+, 4+, 5+, 6+ and 7+ age classes or year classes were 15.4 cm-22.8 cm, 21.9 cm-33.8 cm, 25.0 cm-41.5 cm, 36.8 cm-47.8 cm, 41.5 cm-51.4, 51.8 cm-56.4 cm and 57.4 cm, respectively (Table 1). The maximum growth was attained first two years of life (Fig 1). According to Oliva-Paterna *et al.* (2002) *Cobitis paludica* grows rapidly during the year before first spawning (second year). A high growth rate during the first year has been observed in other small or large fish species (Fernandez-Delgado and Herrera 1995a, 1995b; Bhatt *et al.*, 2004). Growth in fishes is not throughout the year and the fluctuations in the growth express itself on the scales and skeleton parts (Singh, 1999). According to Gupta and Jhingran (1973) length in different age groups of: *L. calbasu* was I year 188.5 mm, II year 291.0 mm, III year 381.0 mm, IV year 468.5 mm, V year 543:5.mm, VI year 618.5 mm, VII year 681.0 mm and VIII year 731.0 mm in Yamuna river in Allahabad. According to Singh (1999), fish attained 16.49, 25.65, 35.32, 43.09, 48.11, 51.36, 56.57 and 69.15 cm at the end of I, II, III, IV, V, VI, VII and VIII years, respectively in the Ganga and Yamuna rivers at Allahabad.

L. calbasu has three distinct periods of life. Fish enters second period of life after fourth year and third period of life after seventh years. The different phases of life *i.e.* asexual, sexual and old age were recorded. The fish has an active sexual phase then entered in old age. *L. calbasu* attains first maturity in second year (Chondar, 1999). In the present study, non-reproductive accounted about 35% while reproductive age groups constituted 65%. Present study indicate high percentage of reproductive population.

The age structure of the kalbasu sample was characterized by presence of 1+ to 7+ age groups. The percentage 2+ age group was to be maximum 33.68%. The age groups 1+ to 4+ constituted 91.17% of the total stock and small proportion of remaining age groups (5+ to 7+). The present study shows a heavy bottom or broad base pyramid (Fig 2). According to Odum (1971), three kinds of structure can be depicted by age pyramids. Heavy bottom or broad base, bell-shaped and urn-shaped. Heavy





bottom or broad base pyramid indicates rapidly growing population with high percentage of young individuals. Warkentine and Rachlin (1984) reported the age structure of Atlantic silverside, *Menidia menidia* and analysis revealed only 2 age class in stock in which 0+ accounted for 97% while 1+ accounted for 3% indication a very short life-span. The data on age structure can also be used to draw inferences on health of the population, mortality and survival rate (Nikolsky, 1980; Bagenal, 1978; Rounseefel and Everhart, 1985; Nautiyal and Negi, 2004). Jhingran (1959) found 1413 fishes (1+ to 3 + age groups) out of 1716 (1+ to 2 + age groups) fishes in C. *mrigala* from the river Ganga. Kamal (1969) found 194 fishes (1 + to 3 + age groups) out of 244 fishes (1+ to 8+ age groups) in C. *mrigala* in the river Yamuna. Nautiyal and Negi (2004) while studying age structure of *Barilius bendelisis*, found 94.12% in 0+ and 1+ age groups. The age groups 2+ to 4+ accounted for 73% in *Tor putitora* in foothill section of the river Ganga (Bhatt *et al.*, 2000). Kendeigh (1980) stated that the number of age class in a population is greater when the survival rate are high. However, high ratio

Table 1 : Mean lengths and percentage composition of Labeo calbasu at various ages as estimated by scale method from the Ghaghara river at Faizabad.

S. No.	Year class	Mean length (cm)	Length range (cm)	No. of Specimen	Percentage
1	1+	18.7	15.4-22.8	52	26.94
2	2+	27.8	21.9-33.8	65	33.68
3	3+	35.7	25.0-41.5	37	18.17
4	4+	41.8	36.8-47.8	22	11.39
5	5+	46.9	41.5-51.4	11	5.69
6	6+	54.9	51.8-56.4	5	2.59
7	7+	57.4	57.4	1	0.52

of immature to adults are characteristics when population are recovering from catastrophes.

ACKNOWLEDGEMENT

The authors acknowledge the academic support and facilities provided by the Head, Department of Zoology, University of Allahabad, Allahabad.

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Journal of Natural Resource and Development 2(1):55-58, 2007

EFFECT OF FOLIAR APPLICATION OF CYTOZYME AND MICROELEMENTS ON GROWTH AND FLOWERING BEHAVIOUR OF AFRICAN MARIGOLD

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ABSTRACT

Results of the field experiment revealed that growth of marigold plant was significantly increased due to foliar application of cytozyme and microelements. The production and size of floral heads were also improved significantly by the cytozyme and microelement treatments. The spray of 0.4% cytozyme for 15 days after transplanting and of 0.25% $ZnSO_4$ or $CuSO_4$ for 30 days after transplanting proved significantly effective for a floriferous crop of African marigold.

Key words: *Growth, cytozynme, micronutrients marigold.*

Marigold (*Tagetes erecta* L.) is commonly used for cut and loose flowers in India because of ease in cultivation and adaptability to varying soil and climatic conditions, long duration of flowering and attractively coloured flower heads of excellent keeping quality. The significance of microelements in manorial schedule of horticultural crops has been recognized only in the recent years. Increasing interest has been observed in the use of agrochemicals like cytozyme containing microelement's, cytokinins, enzymes and various plant growth promoting substances. However, information on the effect of cytozyme and micro-elements like zinc and copper on ornamental crops is rather meager. Therefore, an experiment was conducted to study the influence of foliar application of cytozyme, zinc and copper sulphate on growth and flowering behaviour of African marigold.

MATERIALS AND METHODS

The field experiment was conducted during the winters of 2005-06 at Raja Dinesh Singh Krishi Vigyan Kendra, Ainthu, Kalakankar, Pratapgarh, U.P. The soil of experimental area was sandy loam with good moisture-holding capacity and pH 7.8. The treatments of foliar application 0.0, 0.2 and 0.4% concentrations of cytozyme noted as C_0, C_1, C_2 respectively, alongwith 0.0%, 0.25% and 0.50%, each of zinc sulphate, noted as M_0, M_1, M_2, M_3 and M_4, respectively forming fifteen combinations, were tested in the randomized block design with four replications. The seedlings of about 5 week age were transplanted on November 11, 2000 at 30 cm x 30 cm spacing. FYM was applied to all the plots uniformly @ 2 kg per M_2 as basal dose before transplanting along with 5 g each of P_20_5 and K_20 through di-ammonium phosphate and muriate of potash, respectively. The crop was to-dressed only once with 5 g per M_2 of nitrogen through urea at 60 days after transplanting. The parameters of growth and flowering were recorded at the full blooming stage in the first week of March.

RESULTS AND DISCUSSION

Effect of cytozyme on plant growth: A significant change in the growth parameters was recorded due to cytozyme spray. The fresh weight of biomass increased profusely due to application of 0.4% cytozyme with simultaneous increase in the plant height, diameter of main-stem, spread of plant along and across the row, number of primary branches and number of leaves on the longest primary branch. The

application of 0.2% cytozyme was also found significantly effective over control in improving plant growth but 0.4% cytozyme was significantly more effective than its 0.2%. These results are in close conformity with those of Charani (1987). The increase in number of branches and leaves with the spray of cytozyme might be due to the fact that cytozyme increased photosynthetic efficiency on account of stabilization of chlorophyll (Rana and Vashistha, 1985). The improvement in length of the longest primary branch due to application of cytozyme might be due to increased plant vigour which promotes rooting and improves efficiency of nutrient uptake. Overall increase in biomas may be attributed to the fact that cytozyme increases CO_2 fixation and chlorophyll content of leaves.

There has been significant increase in the number and weight of flower heads per plant due to cytozyme spray. The increase in fresh weight of floral heads with the spray of cytozyme over control might be due to mobilization or movement of nutrients in to flowers. Similar effect of cytozyme has been reported by Hooda *et al.* (1983). The size of the floral head was also improved significantly over control by the application of cytozyme. Such changes in the size of floral head and their number per plant were due to cytozyme application which may be attributed to mobilization of auxins and metabolites. The duration required for full blooming since transplanting was curtailed by the application of cytozyme. The duration required for full blooming since transplanting was 99.07 days under control which decreased to 95.40 and 92.30 days when the plants were sprayed with 0.2% and 0.4% of cytozyme, respectively.

Effect of micro-elements on growth and flowering: Foliar application of zinc sulphate particularly at 0.25% concentration caused positive modifications in the growth parameters such as increased plant height, diameter of main-stem spread, of plant along and across the row number of primary branches per plant, length of the longest primary branch, number of secondary branches on the longest primary branch and number of leaves on the longest primary branch, mainly due to participation of zinc in the metabolism of plant as an activator of several enzymes such as

Table 1: Effect of foliar application of cytozyme and micro-elements on growth parameters of African marigold

S. No.	Treatments	Concentration of cytozyme (%)			CD at 5%	Concentration of micro-elements					CD at 5%
		0.0%	0.2%	0.4%		0.0%	0.2% $ZnSo_4$	0.50% $ZnSo_4$	0.25% $CuSo_4$	0.50% $CuSo_4$	
1.	Plant height (cm)	58.32	60.18	62.12	0.94	58.96	59.84	60.36	61.27	60.27	1.21
2.	Diameter of main stem (cm)	1.48	1.63	1.69	0.06	1.52	1.56	1.63	1.66	1.64	0.07
3.	Spread of plant along the row(cm)	38.18	40.04	41.16	0.69	38.61	39.51	40.03	40.65	40.16	0.89
4.	Spread of plant across the row(cm	37.78	40.07	41.39	0.92	38.51	34.51	39.83	40.67	40.23	1.19
5.	Number of primary branches on the plant	11.78	13.07	14.20	0.29	12.52	12.72	13.00	13.78	13.40	0.37
6.	Length of the longest primary branch (cm)	35.69	39.00	41.85	0.60	36.98	37.95	39.48	40.16	39.65	0.78
7.	Number of secondary branches on the height primary branch	5.92	6.54	7.07	0.30	6.07	6.38	6.55	6.80	6.75	0.39
8.	Number of leaves on height primary branch	36.52	44.22	48.59	0.74	40.77	41.75	33.38	45.38	44.27	0.95
9.	Fresh weight of plant canopy(g)	289.50	325.15	368.45	8.96	311.17	317.17	327.50	348.42	333.50	11.57

carbonic anhydrase, alcohol dehydrogenase and pyridine nucleotide dehydrogenase. Similar effect of $ZnSO_4$ on crop plants have been reported by Barman and Pal (1993). The effect of $ZnSO_4$ treatments was significant on the fresh weight of plant canopy as evinced by the application of 0.50% spray of $ZnSO_4$ which produced the maximum fresh weight of biomass (327.50 gm) being significantly more over other treatments (Mo and Mi).

Likewise, there were considerable manifestations in the growth characters due to $CuSO_4$ spray. Copper has been capable of acting as electron carrier in enzyme system which brings about rapid oxidation-reduction in plants. The foliar application of copper ($CuSO_4$) increased the plant height over Mo (control). The copper sulphate treatment significantly increased the diameter of main-stem simultaneously and also the spread of plant along and across the row. Under Mo the values of these parameters were 38.61 cm and 38.51 cm in comparison to 40.65 cm, respectively with the application of 0.25% $CuSO_4$ spray. These results clearly prove, the growth-promoting effect of spray of 0.25% $CuSO_4$. The number of primary branches and length of the longest primary branch also increased significantly by the foliar application Of $CuSO_4$ (0.25%). As a result, the fresh weight of plant canopy increased significantly over control by the foliar application of $CuSO_4$.

The effect of $ZnSO_4$ treatments was significant on the duration required for full blooming. The size of the largest floral head with the application of 0.50% $ZnSO_4$ spray has been increased significantly over control. Similar effect of $ZnSO_4$ spray was noticed on the number of floral heads per plant accomplished with significant superiority of M_3 (21.58) over Mo (17.91). These results are in consonance to those of Rathore *et al.* (2000). The fresh weight of floral heads per plant (50.08) with the spray of 0.50% zinc sulphate, also increased over control (47.33 g). Similar effects of zinc sulphate have been reported by Ganta and Mitra (1993).

Table 2: Effect of foliar application of cytozyme and micro-elements on flowering behaviour of African marigold

S. No.	Treatments	Concentration of cytozyme (%)			CD at 5%	Concentration of micro-elements					CD at 5%
		0.0%	0.2%	0.4%		0.0%	0.2% $ZnSo_4$	0.50% $ZnSo_4$	0.25% $CuSo_4$	0.50% $CuSo_4$	
1.	Duration required full blooming (Days)	99.07	95.40	92.30	0.48	97.14	96.61	95.44	94.06	94.69	0.52
2.	Size of the largest floral head(cm)	8.92	9.20	9.33	0.08	9.01	9.07	9.19	9.25	9.22	0.10
3.	Number of flower heads per plant	17.91	20.05	21.76	1.05	18.90	19.10	19.45	21.58	20.50	1.35
4.	Fresh weight of floral head per plant (g)	45.25	48.90	55.10	1.70	47.33	48.42	50.08	51.75	51.17	2.20

The duration required for full blooming was reduced significantly by the application of 0.25% $CuSO_4$. A similar impact Of $CuSO_4$ was also noted on the size of the largest floral head. The number of floral heads per plant under the influence of 0.25% copper sulphate (M_1) also revealed significant increase over control (Mo). Thus, foliar application of copper sulphate brought about prolific flowering which coincided with the results reported by Bandopadhyay *et al.* (1998).

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Journal of Natural Resource and Development 2(1):59-64 2007

SCREENING OF MINERAL CONTENTS IN SOME APPLE CULTIVARS (*MALUS PUMILA* MILL.) COMMONLY GROWN IN WESTERN HIMALAYAN REGION

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ABSTRACT

A study was conducted during year 2002 in which mineral contents were screened in 15 apple cultivars *viz* Hara Pichola, Faini, Apple No. 88, Green Sweet, Tom King, Apple No. 12, Full bench, Delicious, Apple No. 103, Painter Wonder, Winter, Golden, Crokus, Rimer and Barhingum, which are being grown in apple orchards of Western Himalayan region. Minerals like sodium, potassium, calcium, phosphorus, lithium, iron, copper, zinc, manganese and cobalt were analyzed. Maximum phosphorous, copper and zinc contents were reported in cv. Barhingum. Painter Wonder was rich in sodium and lithium. Maximum concentration of calcium and manganese were present in cv. Crocus. Iron was observed highest in cv. Winter while cv. Delicious was rich in potassium. Out of 15 cultivars Barhingum, Crokus, Winter, Delicious and Painter Wonder were found superior in mineral contents.

Key words : *Mineral contents, atomic absorption spectrophotometer, flame photometer, cultivars, bio-chemical composition, Malus pumila , Micro-elements.*

Apple (*Malus pumila* Mill. Syn. *M. communis* DC. *Pyrus malus* Linn.) is small deciduous trees of temperate zone of western Himalaya. Apple fruits are fleshy pome, sub globose of varying size, shape and colour . It occupies the most important position among fruits of temperate region. The bio-chemical composition of apple fruits varies with variety, climatic condition during growing season and the stage of maturity (Anonymous, 1962). In apple fruits mineral contents are present in ample quantity and considered valuable for human nutrition. It is a good source of potassium. Some earlier workers had observed variation in mineral contents in different parts of apple fruit during development and found that total content of each mineral in pulp tissues increased during fruit development, this was relatively great for Na, K, Fe, Cu and P and moderate for Mg, Ca and Mn (Iwane, 2000). Fruits of some apple cultivars were also screened for mineral contents by different workers (Ferguson *et al.*, 1983; Quast, 1983; Gherghi *et al.*, 1981) and similar trends of mineral contents were observed by them. The effect of size of sub sample on mineral analysis was found greater for Ca than N, P, K and Mg by (Samuelson, 1983). The interactions of copper and zinc with calcium in apple cultivars were also studied by few workers (Watkins *et al.*, 1982). However, very scanty information is available on mineral composition of apple cultivars which are being grown in different orchards of western Himalayan region. Therefore, screening of mineral contents in apple cultivars and to identify cultivars rich in mineral contents in the aim of the present study.

MATERIALS AND METHODS

Marketable size fruits of apple cultivars namely Hara Pichola, Faini, Apple No.88, Green Sweet, Tom King, Apple No.12, Full Bench, Delicious, Apple No.103, Painter Wonder, Winter, Golden, Crokus, Rimer and Barhingum were collected from apple orchards located at Mukteshawar, Paharpani, Ramgarh and Hartola regions of Nainital district of Uttaranchal with their correct identification. The fruits were washed, oven dried and moisture free, dried samples were kept in airtight sample containers.

One gram dried sample was first digested with 15 ml of triple acid mixture (10 part HNO_3+4 parts of $HClO_4$+2 parts H_2SO_4) at 110°C and reduced to about 1.0 ml. The digested residue was dissolved in triple distilled water, filtered and diluted to 100 ml. This solution was used for the estimation of minerals. In similar condition blank samples were also prepared. Samples of each cultivars were taken in three replications.

Reference standards were prepared from E. Merck, AAS Spectrosol (1000 mg L-1). Estimation of element like Na, K, Ca and Li were carried out by AIMIL, photoflame, photometer, New Delhi, while Fe, Co, Mn, Cu and Zn were determined by Atomic Absorption Spectrophotometer, model 4129, Electronic Corporation of India Ltd, Hyderabad (A.P.). The instruments were calibrated by using standard solutions (0.20^{-10} mgL^{-1}) of above mentioned elements.

RESULTS AND DISCUSSION

Calculation of data was carried out on mg per 100 g fresh weight of apple fruit. Concentration range and mean value of Na, K, Ca, P and Li are given in Table 1, while Fe, Cu, Zn, Mn and CO are mentioned in Table 2.

It is evident from the data that potassium, calcium and phosphorus were the most prominent minerals in concentration terms. The concentration of minerals in analyzed samples were found almost in similar trend as reported by earlier workers (Ferguson et. al., 1999; Quast,1983; Gherghi *et al.*, 1981) It was observed from Table 1 that the concentration range of sodium varied from 1.22 mg to 2.86 mg/ 100 g fresh wt. of apples. Highest concentration of sodium (2.86 mg) was found in cultivar Painter Wonder followed by Crokus (2.33 mg) and least quantity (1.22 mg) present in cv. Apple No.88 (Fig. 2). Potassium on the other hand ranged between 49.43 mg to 90.57 mg. Maximum concentration of potassium (90.57 mg) was found in cv. Delicious followed by (86.90 mg) in Painter Wonder (Fig.1). Calcium content ranged between 5.27 mg to 9.17 mg cv. Crokus reported highest calcium (9.17 mg) while lowest calcium (5.27 mg) was found in cv. Full Bench (Fig.1). Concentration of phosphorus varied from 8.29 mg to 14.09 mg in cv. Barhingum maximum phosphorus (14.09 mg) was reported followed by Delicious (13.17 mg) (Fig.1). Lithium was ranged between 0.47 mg to 1.16 mg in different cultivars. Highest lithium (1.16 mg) was present in cv. Painter Wonder and least quantity (0.47 mg) was observed in Faini (Fig. 2).

Micro-element iron was ranged between 0.91 to 3.78 mg. Highest iron concentration (3.78 mg) was found in cv Winter followed by (3.14 mg) in Barhingum while least quantity of iron (0.91 mg) was observed in cv. Full Bench (Fig. 2). Copper content varied from 0.02 mg to 0.32 mg. Maximum copper (0.30 mg) in Crokus and least copper content (0.02 mg) was observed in cv. Full Bench (Fig. 3). Concentration of zinc ranged between 0.02 mg to 0.21 mg . In cv. Barhingum maximum zinc content (0.21 mg) was reported, followed by Crokus (0.20 mg) while least zinc (0.02 mg) was found in Apple No.103 (Fig. 3). Manganese content varied between 0.02 mg to 0.16 mg. Maximum concentration of manganese (0.16 mg) was present in Crokus cultivar, followed by (0.15 mg) in Apple No.12 and least quantity (0.02 mg) was observed in Apple No.103 (Fig. 3). Cobalt was found absent in all apple cultivars.

From present study it is observed that maximum quantity of phosphorus, copper and zinc were present in cv. Barhingum. Painter Wonder was found rich in sodium and lithium. Highest concentration of calcium and manganese were observed in cv. Crokus . Iron was found maximum in cv. Winter while in Delicious potassium was maximum. Hence it can be concluded that apple cultivars Barhingum, Crokus, Winter, Delicious and Painter Wonder are superior cultivars for mineral contents. Hence these cultivars may be used for commercial scale cultivation in western Himalayan region.

Table 1. Variation of mineral contents in apple cultivars

S. No.	Name of Cultivar	Plant part screened	Metal contents (mg/100g fresh wt.)											
			Sodium		Potassium		Calcium		Phosphorus		Lithium			
			Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean		
1.	Hara Pichola	Fruit	1.30-1.74	1.52	59.76-75.92	67.84	5.39-7.01	6.05	7.50-9.08	8.29	0.66-0.93	0.80		
2.	Faini	Fruit	1.49-2.06	1.77	40.65-58.21	49.43	4.93-6.31	5.45	8.20-10.82	9.53	0.38-0.55	0.47		
3.	Apple No 88	Fruit	1.02-1.41	1.22	58.59-70.50	64.55	5.42-8.16	6.75	7.68-8.92	8.47	0.58-0.88	0.73		
4.	Green Sweet	Fruit	1.77-1.93	1.85	69.01-74.32	71.66	5.39-7.91	6.58	9.26-12.64	10.85	0.87-1.06	0.97		
5.	Tom King	Fruit	1.75-2.24	1.99	43.58-61.31	52.44	4.76-5.61	5.09	7.21-11.08	9.55	0.68-0.87	0.78		
6.	Apple No.12	Fruit	1.54-1.88	1.71	74.93-98.55	86.74	7.86-8.94	8.27	12.25-13.01	12.64	0.66-1.28	0.97		
7.	Full Bench	Fruit	1.15-1.48	1.31	66.38-77.45	71.92	4.63-6.25	5.27	7.84-9.60	8.79	0.78-0.98	0.88		
8.	Delicious	Fruit	1.48-1.94	1.71	81.53-99.61	90.57	6.74-9.74	8.24	12.60-13.80	3.17	0.85-1.02	0.92		
9.	Apple No103	Fruit	1.21-1.85	1.53	54.41-70.20	62.31	4.53-6.73	5.86	8.12-11.75	9.90	0.54-0.84	0.69		
10.	Painter Wonder	Fruit	2.33-3.39	2.86	81.03-92.58	86.90	5.76-7.27	6.43	11.61-12.56	12.08	0.83-1.48	1.16		
11.	Winter	Fruit	1.72-2.47	2.10	61.48-72.62	67.05	4.52-7.42	5.64	9.30-10.52	10.02	0.55-0.91	0.73		
12.	Golden	Fruit	1.64-2.16	1.90	57.34-72.22	64.78	5.40-8.00	6.57	9.86-11.56	10.77	0.57-0.76	0.66		
13.	Crokus	Fruit	1.94-2.72	2.33	57.40-72.76	65.08	8.49-9.84	9.17	8.82-10.87	10.01	0.48-0.85	0.66		
14.	Rimer	Fruit	1.31-2.00	1.65	56.91-65.03	60.97	5.57-7.37	6.30	10.52-11.62	11.02	0.43-0.62	0.52		
15.	Barhingum	Fruit	1.63-2.62	2.13	63.49-74.90	69.20	6.77-8.61	7.86	13.28-14.98	14.09	0.51-0.70	0.61		
	C.D. at 5%			0.52		12.21		1.76		1.83		0.27		
	C.D. at 1%			0.70		16.44		2.37		2.46		0.37		
	CV			16.91		10.65		15.91		10.34		21.27		

Table 2. Variation of mineral contents in apple cultivars

S. No.	Name of Cultivar	Plant part screened	Metal contents (mg/100g fresh wt.) Iron Range	Iron Mean	Copper Range	Copper Mean	Zinc Range	Zinc Mean	Manganese Range	Manganese Mean	Cobalt Range	Cobalt Mean
1.	Hara Pichola	Fruit	1.55-2.14	1.85	0.06-0.10	0.08	0.04-0.07	0.05	0.02-0.03	0.02	0.00	0.00
2.	Faini	Fruit	1.14-1.73	1.44	0.14-0.28	0.23	0.13-0.16	0.14	0.05-0.14	0.09	0.00	0.00
3.	Apple No. 88	Fruit	1.23-2.07	1.65	0.03-0.04	0.34	0.04-0.07	0.06	0.03-0.04	0.04	0.00	0.00
4.	Green Sweet	Fruit	1.22-2.28	1.75	0.05-0.10	0.07	0.05-0.14	0.10	0.02-0.03	0.02	0.00	0.00
5.	Tom King	Fruit	0.96-1.49	1.23	0.09-0.13	0.11	0.04-0.06	0.05	0.03-0.04	0.03	0.00	0.00
6.	Apple No.12	Fruit	1.22-2.46	1.84	0.03-0.34	0.03	0.03-0.16	0.09	0.10-0.20	0.15	0.00	0.00
7.	Full Bench	Fruit	0.69-1.13	0.91	0.01-0.03	0.02	0.01-0.02	0.02	0.02-0.04	0.03	0.00	0.00
8.	Delicious	Fruit	0.91-1.36	1.14	0.02-0.04	0.03	0.06-0.10	0.08	0.03-0.04	0.03	0.00	0.00
9.	Apple No.103	Fruit	0.85-1.27	1.06	0.06-0.08	0.07	0.02-0.03	0.02	0.02-0.03	0.02	0.00	0.00
10.	Painter Wonder	Fruit	2.40-3.46	2.93	0.06-0.09	0.07	0.08-0.11	0.10	0.06-0.08	0.07	0.00	0.00
11.	Winter	Fruit	2.79-4.78	3.78	0.04-0.06	0.05	0.06-0.09	0.07	0.04-0.06	0.05	0.00	0.00
12.	Golden	Fruit	1.81-2.05	1.81	0.04-0.06	0.05	0.08-0.10	0.09	0.02-0.03	0.02	0.00	0.00
13.	Crokus	Fruit	1.80-2.58	2.19	0.22-0.36	0.30	0.07-0.23	0.20	0.14-0.16	0.16	0.00	0.00
14.	Rimer	Fruit	1.66-1.97	1.81	0.18-0.32	0.23	0.08-0.10	0.09	0.09-0.12	0.11	0.00	0.00
15.	Barhimgum	Fruit	2.65-3.63	3.14	0.24-0.39	0.32	0.18-0.24	0.21	0.13-0.16	0.14	0.00	0.00
	C.D. at 5%			0.74		0.69		0.43		0.03		0.00
	C.D. at 1%			0.99		0.93		0.57		0.04		0.00
	CV			23.42		26.55		28.04		29.89		0.00

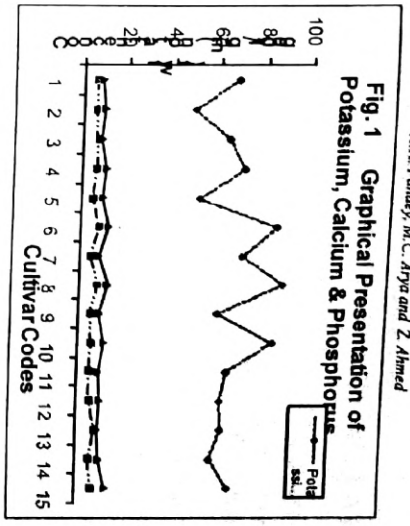

Fig. 1 Graphical Presentation of Potassium, Calcium & Phosphorus

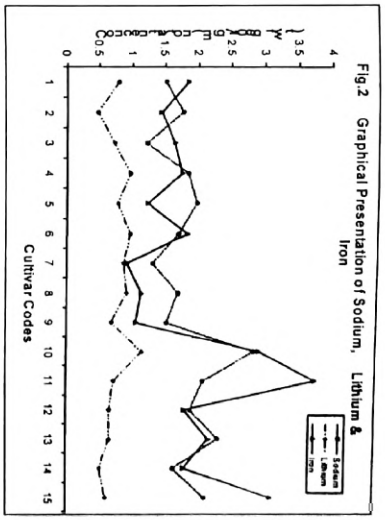

Fig.2 Graphical Presentation of Sodium, Lithium & Iron

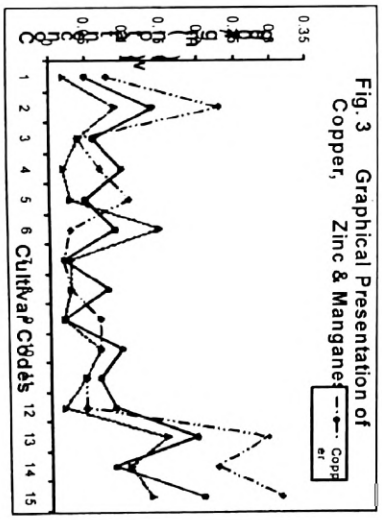

Fig.3 Graphical Presentation of Copper, Zinc & Manganese

Cultivar Code Name of Cultivar

1 Hara Pichola
2 Faini
3 Apple No. 88
4 Green Sweet
5 Tom King
6 Apple No. 12
7 Full Bench
8 Delicious
9 Apple No. 103
10 Painter Wonder
11 Winter
12 Golden
13 Crokus
14 Rimer
15 Barhimgum

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Journal of Natural Resource and Development 2(1):65-67, 2006

RESPONSE OF GARLIC TO *AZOSPIRILLUM* INOCULATION UNDER VARIOUS LEVELS OF NITROGEN

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ABSTRACT

To assess the response of garlic to *Azospirillum* a bio-fertilizer under various levels of nitrugen. Application of 100 kg nitrogen per hectare produce the maximum bulb yield of 146.5 quintal per hectare with clove inoculation whereas soil application also increased the shoot length and number of cloves per bulb.

Key words : Garlic yield, Azospirillum inoculation various levels of nitrogen.

Garlic is an important spice or condiment cultivated through out the country. The production cost of nitrogenous fertilizers is increasing constantly over the years due to its high energy budget process based on fossil fuel. Therefore, it is necessary to devise such improved practices of farming which can minimize the cost and also dependency on chemical fertilizers.

MATERIALS AND METHODS

Hence the present field study was conducted during Rabi season of 2005-06 at Dept. of Horticulture, Allahabad Agricultural Institute (Deemed University), Allahabad. The soil of the experimental field was sandy loam in texture, neutral in reaction and low in available nitrogen (212.6 kg ha-1) and phosphorus (16.2 kg ha-1) while medium in available potash (356.0 kg ha-1). Twelve treatment combinations, consisted of three bioinoculant treatments (no inoculation, inoculation of seed and application of culture with FYM @ 25 kg ha-1) and five levels of nitrogen (0, 25, 50, 75 and 100 kg N ha-1) were arranged in a randomized block design with three replications. The seeds were inoculated by dipping of cloves in thick pastes of carrier based inoculants while soil application of culture was made through mixing it with FYM and broadcasted in the furrows. A basal dose of 50 kg. P_2O_5 and 50 kg K_2O ha-1 was also applied to all the plots where as the nitrogen was applied as per treatments. The cloves were planted at 15 x 5 cm spacing in gross plot of 3.0 x 2.0 m size.

RESULTS AND DISCUSSION

Increasing dose of nitrogen from 0 to 75 kg N ha^{-1} significantly enhanced the shoot length, number of clove / bulb, bulb weight as well as bulb yield. The variations between 75 and 100 kg N ha^{-1} significant. However, the application of 100 kg N ha^{-1} produced the maximum bulb yield of 146.5 q ha^{-1} which was 168.8, 147.8, 118.3 and 62.5 percent higher over 0, 25, 50 and 75 kg N ha^{-1}, respectively. Both the as clove inoculation or soil application significantly increased the shoot length and number of cloves $bulb^{-1}$ over uninoculated control. Improvement in different parameters studied, due to use of *Azospirillum* may be because of the ability of the inoculant to produce some biologically active compounds such as gibberellins and vitamins which can stimulate plant growth. The data further revealed that the soil inoculation was found better in terms of yield and gave 4.3 and 18.3 percent higher yield of garlic over clove inoculation and control, respectively.

Interaction between inoculation and nitrogen

Table 1: Response of garlic to Azospirillum inoculation and nitrogen levels

Treatments	Shoot Length (cm)	No. of leaves /plants	No. of cloves / bulbs	Bulb Weight (g)	Bulb Yield (q ha^{-1})
Nitrogen (Kg ha^{-1})					
0	19.9	7.3	17.5	7.8	54.5
25	31.7	9.0	21.4	11.1	88.6
50	36.6	10.2	24.6	16.2	119.0
75	40.2	10.6	28.5	19.2	135.1
100	41.2	11.0	29.5	19.9	146.5
SEm	1.28	0.46	0.90	0.91	4.2
CD at 5% Inoculation	3.5	1.5	2.4	2.8	12.2
Uninoculation	30.7	8.8	17.4	12.9	94.9
Cloves inoculation	35.7	9.6	26.7	15.7	112.2
Soil inoculation	35.9	10.1	27.4	17.1	117.0
SEm	1.2	0.34	3.02	0.85	2.92
CD at 5%	3.9	1.0	9.2	2.6	8.80

Table 2: Interaction effect of inoculation method and nitrogen levels of yield of garlic (q ha^{-1})

N levels (kg ha^{-1})	Without inoculation	Cloves inoculation	Soil inoculation
0	48.8	61.9	52.8
25	78.0	98.5	89.5
50	101.5	128.2	127.5
75	122.0	138.3	150.2
100	135.5	139.5	165.4
	I	N	I x N
SEm	2.9	4.2	7.5
CD at 5%	8.8	13.2	22.5

was found significant in respect of yield. The combination of either cloves inoculation or culture application with FYM supplemented with 50 kg N ha^{-1} produced as good as yield of 128.2 and 127.5 q ha^{-1} recorded with 75 kg N ha^{-1} alone. Further, it was interesting to note that the cloves inoculation performed well only upto the 50 kg N ha^{-1} whereas culture application alone with FYM @ 25 kg N ha^{-1} exhibited quite good response with incremental nitrogen. Thus, present findings clearly indicated that as seed treatment gave better yield of garlic with lower level of nitrogen (50 kg N ha^{-1}). To achieve higher tonnage, alongwith FYM as soil supplemented with 75 kg N ha^{-1} gave as much bulb yield as with 100 kg N ha^{-1} alone. These findings are in accordance with the findings of Wange (1995) and Ganeshe (1996). Joi and Shinde (1976) also reported 22 percent increase in yield of onion crop due inoculation .Thus, an application of culture with FYM as soil application can economized about 25 kg nitrogen and thereby reduced the cost of cultivation.

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Journal of Natural Resource and Development 2(1):68-70, 2007

EFFECT OF GROWTH HORMONES OF THE VEGETATIVE SURVIVAL, AKINETE OR ZOOSPORANGIA FORMATION IN SOME SELECTED ALGAE

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ABSTRACT

The survivability of vegetative cells in all algae studied, formation of akinetes, their viability and germination in *Anabaena iyengari*, *Westiellopsis procifica*, *Nostochopsis lobatus* and *Pithophora oedogonia* and the *formation of zoosporangia*, their viability, and the germination of zoospores in Cladophora glomerata and Rhizoclonium hieroglyphicum all were maximum at 0.1ppm of any of growth hormones used. It decreased with an increase in level of growth hormones from 1.0 to 100 ppm.

Key words : Growth hormones, vegitative servival, zoosporangia, selected algae.

Very little in known about the effects of growth hormones on the process of akinete or zoosporangium formation and germination in algae. Experimental work concerning the effects of indole acetic acid (IAA) and gibberellic acid (GA) on the stimulation of algal growth in available (Saona, 1964; Ahmad and Winter, 1968; Sundaraligam and Govindraj 1977) but reports on the effects of plant growth hormones on the sporulation and spore germination in algae are scanty.

IAA at some low levels increased the formation of zoospores in *Ulothrix* (Conrad *et al.* 1959) spores in Derbesia (Hustede, 1964) akinetes in *Stigeoclonium* (Agrawal and Sharma, 1984) oogonia in *Oedogorium* (Singh and Chaudhary, 1988), but the same hormone IAA inhibited production of sporangia in conchocelis phase of porphyra (Dring, 1967) Gibberellic acid (GA_3) also at same low level increased formation of zoospore in *Ulothrix* (Conrad *et al* 1959).

Oogonia in Oedogonium spp (Singh and Chaudhary, 1988) Similarly, kinetin at some low concentration stimulated formation of caps in *Acetabularia* (Spencer, 1968) but delayed the discharge of gametes in *Fucus* (Moss, 1967).

MATERIALS AND METHODS

Algal materials and growth condition : The algae used in the present investigation were blue green algae. *Anabaena iyengari Var. tenuis* RAO, *Westilleopsis procifica* JANET, *Nostochopsis lobatus* and green algae, *Pithophora oedogonia* (MONT.) WITROCK, *Cladophora glomerate* (L) *KUETZING* and *Rhizoclonium hieroglyphicum* (C.A.Ag) *KUETZING* These algae were grown in liquid BG 11 medium (Stanier *et al.* 1971) The pH was adjusted prior to autoclaving to 7.5. Cultures were maintained in controlled culture condition at 22° C and light intensity of 40 μmol $m^{-2}S^{-1}$ from day light fluorescent tubes for 16 h a day.

Growth hormones used were IAA, GA_3 and Kinetin. These were dissolved separately in minimal volume of 80% ethanol and mixed slowly into a known amount of autoclaved and cooled culture medium so as to prepare the hormone. Solution of desired concentration the range of concentration of hormones used range between 0.1 to 500 ppm. Controls were maintained containing the same amount of ethanol.

The seven day old actively growing vegetative filaments were used as a source of inoculum. All inoculated culture were placed in culture chamber and were examined on 60 days of inoculation. To observe viability of akinetes or zoosporangia formed in presence of hormone, they were harvested from the

hormone solution respectively after 60 and 45 days of inoculation and were inoculated into basal medium and placed in culture chamber.

The percentage of germination of akinete and zoospores was estimated on 15 day of inoculing. The survival of vegetative cells was determined by counting the number of dead vegetative cells, if any, the formation of akinete or zoosporangia by counting their number with respect to the total number (about 4000-5000 vegetative cells) from each three replicates 45 after inoculation.

A. Data represent mean of these replicates.
B. Viability similar to those harvested from basal medium.
C. Viability reduced to 5-10% as compared to those harvested from basal medium.
D. No viability at all.

RESULTS AND DISCUSSION

The survivability of vegetative cells in all algae, formation of akinete in *A. iyengari*, *W. prolifica*, *N. lobatus* and *P. oedogonium* and the formation of zoosporangia in *C. glomerata* and *R. hieroglyphicum* all were maximum (that is more than control) at 0.1 ppm of any of growth hormones used. In all algae a studied , the survivability of vegetative cells and the formation of reproductive cells (akinete or zoosporangia decreased with an increase in level of growth hormones from 1.0 to 100 ppm. All algae die at 500 ppm of any all hormones used.

Akinetes or zoosporangia formed at lower concentration (0.1-10 ppm) of any of hormones used were similarly viable like those of control akinetes is zoosporangia but those formed at higher concentration (10-100 ppm) showed loss viability or no viability at all. Abinetes or zoospore germination in any algae studied was maximum at 0.1 ppm of IAA, GA_3 and kinetine GA_3 favoured akinetes and zoospores germination even up to 500 ppm level.

Growth hormones IAA, GA_3 and kinetin at lower concentration of 0.1-100 ppm favoured all life cycle

Table : percentage formation of dead cells (D) in all algae, formation of akinetes (A) and germination of a kinetes (AG) in *A. iyengari*, *N. lobatus*, *W. prolifica* and *P. oedogonium* and Zoosporangia formation (Z) and germinate of zoospores (ZG) in *C. glomerata* and *R. hierocyphicum* at different concentration of growth hormones used.

Plant Growth Hormones	Algae																					
	A. iyengari			W. prolifica				N. lobatus				P. oedogonium				C. glomerata			R. Heirocyphicum		
(ppm)	D	A	AG	D	A	AG	A	D	A	AG	A	D	A	AG	A	D	Z	ZG	D	Z	ZG
Control	15	85	50	4	70	52			2	80	50		10	36	67	4	40	48	7	44	52
IAA 0.1	0	100b	70	0	100b	80		0	90b	74		40	20c	80		6	70b	60	5	80b	72
1.0	5	85b	50	2	92b	60		10	75b	60		55	0	85		10	60	75	20	65b	60
10	40	20c	5	10	15c	10		35	10c	4		60	0	10		20	0	0	40	0	0
100	80	5d	0	30	10d	0		45	4d	0		100	0	-		100	0	0	100	0	0
500	10	0	0	100	0	0		100	0	0		-	-	-		-	-	-	-	-	-
GA3 0.1	0	100b	74	0	100b	68		0	90b	70		15	25c	80		5	50b	59	0	70b	66
1.0	2	80b	70	2	80b	74		7	80b	82		20	3c	75		20	45b	64	10	60b	70
10	30	40b	60	15	60b	80		10	50b	89		100	0	89		20	30c	78	20	45c	85
100	20	15c	55	30	45c	70		50	32c	72		100	0	70		40	10c	60	35	20c	55
500	100	0	0	100	0	60		100	0	66		100	0	70		100	0	47	100	0	50
Kinetin 0.1	0	100b	75	0	100b	70		0	100b	66		20	40b	70		7	55b	60	6	60b	66
1.0	2	90b	60	0	100b	55		0	100b	64		22	25c	6		15	45b	50	12	50b	50
10	50	10d	10	5	30b	20		72	24c	145		30	5b	0		20	7c	0	11	12c	0
100	100	0	0	10	15d	0		15	12d	0		100	-	0		30	0	0	25	0	0
500	-	-	-	100	0	0		100	0	0		-	-	-		100	0	0	100	0	-

stages of different algae but at higher concentration of 10-500 ppm suppressed the survivability of vegetative cells and the formation of akinetes or zoosporangia in all algae studied *A. iyengari* was the most sensitive alga while *R. hierocyphicum* the most resistant to any growth hormones this may be due to dedicate nature of *A. iyengari exogenousely* applied IAA and GA produced an increasing growth response in various algae only upto some concentration and thereafter an inhibition in growth was observed (Conrad *et al*, 1959, Sunderalingam and Govindraj 1977) IAA and GA_3 upto 01. and 10 ppm, respectively did not bring any change in survival of vegetative *colongin stigeoclonium pascheri* but beyond that levels provide inhibitory to colony survival (Agrawal and Sharma, 1984)

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Journal of Natural Resource and Development 3(1): 71-74, 2007

HYPOGLYCEMIC EFFECT OF *POTENTILLA MOONIANA* ROOT EXTRACT ON THE NON-MULBERRY SILKWORMS

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ABSTRACT

The roots of *Potentilla mooniana* is believed to have many medicinal properties including hypoglycemic activity on vertebrates. It is supposed to be a steroid, present in the root of the plant which causes this hypoglycemic activity. It is quite difficult to isolate these metabolite from the plants. Many experiments are being carried out in vertebrates like rats, to identify this factor. This present study was carried out to see whether this root extract has any effect on glucose level of invertebrates. The experiment was done on silkworm which is one of the most voracious animals, with a short life-span. Larvae were separated into four groups with respect to both size and colour. One group was left as control while others were fed with sucrose, sucrose and hypoglycemic factor and hypoglycemic factor only respectively by sparing them on the leaves that were fed to the larva. The sucrose fed showed a hyperglycemic level compared to control while the sucrose feeding along with root extract showed a normal level. The root extract alone did not show any change in glucose level. This indicates that the root extract of *Potentilla mooniana* has some hypoglycemic activity on the hyperglycemia of silkworm.

Key Words *Hypoglycemia, Potentilla Mooniana root, Eri silkworm.*

The extracts of different parts of various plants are being used traditionally, in different parts of world for controlling hyperglycemia. Since the causes for hyperglycemia is different the effect also will not be same for all. The roots of *Potentilla* are chewed with betel leaves traditionally in Northeast Regions of India. This plant is believed to have some medicinal properties including hypoglycemic effect. *Potentilla mooniana* is a prostrate erect herb with yellow flowers. It is widely seen in the temperate lands of Himalayas, from Sikkim to the Khasi Hills in Meghalaya, at an attitude of 1,200-3,600 meters. Generally experiments related to hyperglycemia are done on rats, mice or guinea pigs as their metabolism is closely related to that of human being. Only a few studies have been carried out on the hyperglycemia in invertebrates, especially in insects may be because its carbohydrate metabolism is basically different from ours. But it should be noted that the insects like honeybee and silkworm are known for their economic value from the ancient times. Moreover, honeybee feeds on honey, a highly saturated form of sugar and silkworm larva are one of the most voracious eaters in the world. So they would be having a fantastic and inquisitive method for maintaining sugar level in their body.

So in the present study, the effect of root extract of *Potentilla mooniana* (Weight) on the hyperglycemia, in the fat body and haemolymph of fourth instar larva of Eri silkworm was studied. In this present experiment, a 2% solution of the root stock powder *of Potentilla mooniana* was prepared in distilled water. This solution will here after be described as root extract or hypoglycemic factor.

MATERIALS AND METHODS

The fourth instar larvae of silkworms at this stage the age of the larvae was about 18 days, the peak time of their voracious feeding nature. The larvae were separated into four groups of 20 each in four

different cages in the rearing house. Each set was fed with different treatment :

1. Control
2. Treated with 2% sucrose solution
3. Treated with 2% root extract
4. Treated with 2% sucrose in 2% root extract.

(The 2% root extract of *Potentilla* in water acts as a hypoglycemic factor.)

The haemolymph and fat body of larvae from each set was taken at an interval of 24 hrs and was estimated for its glucose content. The protein profile of each experimental sample was also carried out by SDS-PAGE Techniques. For haemolymph and fat body extraction procedure was used based on the method developed by Fain and Riddiford (1975) and Unni *et al.* (1991). On this subject tomhio *et al.* (2004) and also by Hamdan II (2004) and Shabana *et al.* (1990)

Glucose Estimatic : The glucose present in fat body and haemolymph can be estimated as it is a reducing sugar. Then the amount of glucose per milliliter of haemolymph and per milligram of fat body was calculated. Principles of Nelson Somogyi method were followed for determination of reducing sugar.

The reducing sugars when heated with alkaline copper tartrate reduce the copper from the cupric to cuprous state thus cuprous oxide is formed. When cuprous oxide is treated with arsenomolybdic acid, the reduction of molybdic acid to molybdenum blue take place. The blue colour developed is compared with a set of standards in a colorimeter at 620 nm.

Reagents

Alkaline Copper Tartrate : (A) Dissolved 2.5 g, anhydrous sodium carbonate, 2 gm $NaHCO_3$/ 2.5 gm potassium sodium tartrate and 20 gm anhydrous Na_2SO_4 in 80 mL water and make up to 100 mL. (B) Dissolve 15 g $CuSO_4$ in small volume of distilled water. Add one drop of H_2SO_4 and make up to 100 mL.Mixed 4 mL of (B) and 96 mL of solution (A) before use. Arsenomolybdate Reagent : Dissolved 2.5 g ammonium molybdate in 45 mL water. Added 2.5 mL H_2SO_4 and mix well. Then add 0.3 g disodium hydrogen arsenate dissolved in 25 mL water. Mix well and incubate at 37°C for 24 to 48 hrs. Standard Glucose Solution: Stock 100mg (0.1gm) in 100 mL distilled water (10 mg in 10 mL distilled water) Working standard: 10 mL of stock diluted to 100 mL with distilled water (100 µg/mL)

Weighed 100 mg of sample (in case of fat body and 100 µl in case of haemolymph), extracted with 2 mL of hot 80 % ethanol twice. Collected the supernatant and evaporated by keeping it in water bath at 80°C, and added 5 ml distilled water to dissolve the sugars. Pipetted out 0.4 mL aliquots of the extract in test tube in duplicate and made up the volume to 2 mL with distilled water. Added 1 mL of alkaline copper tartrate reagent to each tube. Then the tubes were left in boiling water for 10 minutes. Added 1 mL of arsenomolybdic acid reagent to all the tubes after cooling them. The volume of each tube was made up to 10 mL and the absorbance was read at 620 nm.

RESULTS AND DISCUSSION

The concentration of glucose in the fat body was found to be comparatively more than haemolymph. There is a considerable increase in glucose level in both fat body and haemolymph of 2% sucrose treated leaves than the control. The level is more in 48 hrs than in 24 hrs of treatment. The treatment with root extract containing the "hypoglycemic factor" along with sucrose, maintained the glucose level to a normal level as that of the control in both the tissues. The treatment of root extract alone did not make any change in the glucose concentration of both haemolymph and fat body. The treatment with root extract and sucrose has shown some changes in the protein/peptide profiles in both the tissues of silkworm.

Table 1 : Hypoglycemic substance induced changes in total glucose level in the fat body of the larva of silkworm

Glucose present mg/gm of fat body				
Hours of treatment	Control	2% Sucrose Fed	2% root extract Fed	2% Sucrose in 2% root extract
24	1.931	2.42	1.86	1.8
48		3.35	2.48	2.5

Each value is the mean of 4 observations.

Table 2 : Hypoglycemic substance induced changes in total glucose level in haemolymph of the larva of silkworm.

Glucose present mg/gm of haemolymph				
Hours of treatment	Control	2% Sucrose Ped	2% root extract Fed	2% Sucrose in 2% root extract
24	1.15	1.50	1.17	1.7
48		2.15	1.2	

Each value is the mean of 4 observations.

Fig. 1: 10% SDS-PAGE of fat body of silkworm [a: sucrose fed for 48 hours; b: sucrose and root extract fed for 48 hr ; c: sucrose fed for 72 hr. D: control]-haemolymph-[e: root extract and sucrose fed 48 hrs; f: sucrose fed 72 hours ; g: control]

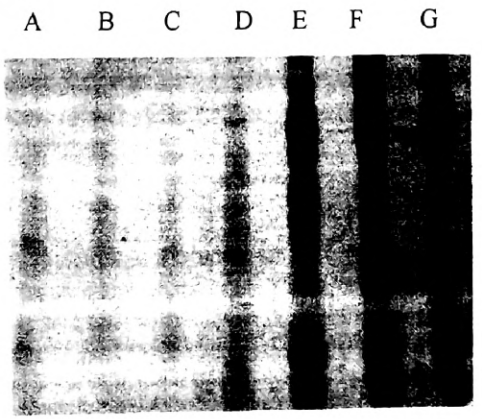
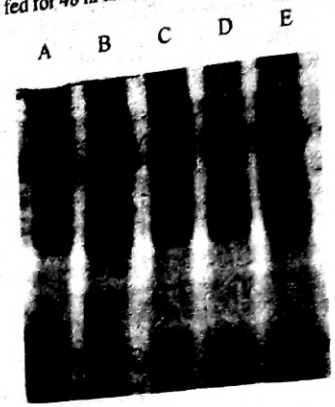


Fig. 2 : 10% SDS-PAGE of haemolymph of eri [a; control, b; sucrose fed for 24 hr; c; sucrose fed for 72 hr; d; sucrose and root extract fed for 48 hr and e; root extract fed for 48 hr



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Journal of Natural Resource and Development 2(1):75-78, 2007

TECHNOLOGY OF KHOA BASED PRODUCTS – A NEW APPROACH

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ABSTRACT

Burfi (T_1), peda (T_2) kalakand (T_3), suras 1 (T_1+T_2, 1:1), suras 2 (T_1+T_3, 1:1), suras 3 (T_2 + T_3, 1:1) were prepared with cow (Sahiwal x Jersey) milk using 6% sugar, 4% fat and 8.5% SNF. The fresh yield of kalakand was higher (P<0.01) than burfi and peda. The flavour score of kalakand and the kalakand mixed products were higher (P<0.01) than the rest of the groups. The differences in chemical composition of all the dried products were not significant.

Key Words : *Technology, khoa based product - new approach*

Burfi and peda are the oldest most popular khoa based indigenous sweets in the country. These products have high nutritional value and delicious taste. Some of the literatures on the technology of these products (Ramna et at, 1983, Ajeet and Bikram, 2003 and Wakchaure et al,2003) are available but the literatures on the new products develop with the combinations of kalakand are not available in the country. Keeping in view the above facts some new products based on khoa have been tried in this investigation.

MATERIALS AND METHODS

Fresh clean cow (Sahiwal x Jersey) milk was procured from the organized dairy farm and standardized for 4.0% Fat and 8.5% SNF. Burfi (T_1) and Peda (T_2) were prepared as per procedures given by Dey (1983). The kalakand (T_3) was prepared as per technique described by Suresh and Jha (1994) using 6% Sugar in milk before pad formation. The mixed products – suras 1 (burfi + peda, 1:1- T_4), suras 2 (burfi + kalakand 1:1 - T_5) and suras 3 (peda + Kalakand, 1:1 - T_6) were prepared after proper mixing with the help of food processor when they were in warmed condition. Each product was repeated four times and tested for sensory evaluation using score card prescribed by Nelson and Trout (1981), total solids, fat and SNF as per standard procedures given in AOAC (2000). The data were computed under factorial randomized design using standard procedure given by Panse and Sukhatme (1978).

RESULTS AND DISCUSSION

The average yield of kalakand (25.37%) was significantly (P<0.05) higher than the values obtained from suras-3 (25.06%), suras-2 (24.98%), peda (24.74%), suras-1 (24.66%) and burfi (24.60%). The difference between the yield of burfi and peda alone was not significant (Table -1), but the differences in the values obtained from peda to kalakand and burfi to kalakand both were very high (P<0.01). The fresh yield of kalakand was higher due to holding of higher amount (P<0.05) of water in the granules than the values obtained from the rest of the products.

The yield of kalakand in the present study was higher than the value (18.76%) obtained by Moulick *et al.* (1996). The higher yield in the present study was due to higher total solids (12.5%) present in the milk than the values obtained by Moulick et al (1996) using cow milk of low total solids (9.68 to 10.85% TS). The total solids in burfi was the highest (83.88%) followed by groups T_4 (83.72%), T_2 (83.67%), T_5 (83.34%), T_6 (83.24%) and T_3 (82.86%). These

TABLE 1 : Average yield and chemical composition of the products (%)

Products	Fresh yield	Dry weight basis			
		Yield	Fat	Protein	Total ash
Burfi (T_1)	24.60	83.88	22.81	18.56	2.42
Peda (T_2)	24.74	83.67	22.79	18.52	2.40
Kalakand (T_3)	25.37	82.86	22.88	18.59	2.38
Suras – 1 (Burfi+Peda – T_4)	24.66	83.72	22.79	18.54	2.39
Suras – 2 (Burfi+Kalakand) – T_5)	24.98	83.34	22.83	18.58	2.40
Suras – 3 (Peda+Kalakand – T_6)	25.06	83.24	22.84	18.57	2.40
CD 1% 5%	0.680.41	0.630.28	0.130.8	0.120.08	0.090.05

TABLE 2 : Sensory evaluation scores of the products

Products	Flavour	Body & texture	Colour and appearance
Burfi (T_1)	7.89±0.09	7.89±0.11	7.99±0.07
Peda (T_2)	7.92±0.08	7.92±0.06	8.02±0.08
Kalakand (T_3)	8.09±0.05	7.93±0.04	8.07±0.12
Suras – 1(Burfi+Peda – T_4)	7.92±0.04	7.91±0.06	8.02±0.04
Suras – 2(Burfi+Kalakand) – T_5)	8.18±0.03	7.94±0.03	7.98±0.07
Suras – 3(Peda+Kalakand – T_6)	8.12±0.07	7.93±0.05	8.02±0.06
CD 1%5%	0.170.07	0.120.06	0.110.05

values were at par with the findings reported by Ray *et al.* (1999), when peda was prepared by cow milk.

The fat content in kalakand (22.86%) was apparently higher than the value obtained from burfi (22.81%) and peda (22.79%). Slightly higher fat content in kalakand may be due to lower loss of volatile fatty acids as some parts of this acid may be protected within the granules.

Moulick et al (1996) have reported similar fat content (22.32%) in peda as found in the present study. The product of groups T_1, T_2, T_3, T_4, T_5, and T_6 contained 18.56, 18.55, 18.59, 18.54, 18.58 and 18.57 per cent protein and 2.42, 2.40, 2.38, 2.39, 2.40 and 2.40 per cent total ash, respectively. The differences between the products in respect of protein and ash were not significant.

The flavour score of peda, (7.92%), burfi (7.89%) and suras-1 (7.92%) did not vary significantly (Table -2) but the differences between the flavour score of these products to kalakand (8.09%) were very high ($P<0.01$). The flavour score was improved $P<0.01$ when Kalakand was blended with burfi (8.18%) and peda (8.12%) than the values obtained from the groups T_1, T_2 and T_4. The flavour score was also high ($P<0.05$) in all the kalakand mixed products than the value obtained from kalakand alone. The differences in the body and texture score between the groups T_1 (7.89%), T_2 (7.93%), T_3 (7.91%) and T_4 (7.92%) were not significant. The body and texture score were apparently higher when kalakand was mixed with burfi (7.94%) and peda (7.92%) than the values obtained from the rest of the groups. The colour and appearance of kalakand (8.07%) was significantly ($P<0.05$) higher than the values found in the rest of the groups. The differences in colour and appearance between the groups T_1 (7.99%), T_2 (8.02%), T_4 (8.02%), T_5 (7.98%) and T_6 (8.02%) were not significant. Palit and Pal (2005) reported that the chemical composition, sensory, rheological and microbiological qualities of market burfi show large variations, because of it is generally prepared on small scale by private traders (halwais).

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Journal of Natural Resource and Development 2(1):79-82, 2007

SCOPE OF LIVESTOCK FARMING IN RURAL MAHARASHTRA FOR SUSTAINABLE LIVELIHOOD DEVELOPMENT

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Agriculture supported by Animal Husbandry is the back bone of our country and the State in particular. Livestock rearing has been integral part of farming system of our country. Agriculture and livestock sector are complementary to each other. Animals can utilize agriculture byproducts for producing valuable products like milk, meat and wool. The farm waste like dung, urine and bedding material can be a good source of organic fertilizer and can be most efficiently utilized in gobar gas plant which also provides clean and cheap fuel along with much needed manure. The organic fertilizer can also be used for producing organic foods and vegetable which is gaining popularity among more health conscious consumers.

Our livestock development programmes in the State is affected due to depletion of pasture, low public investment, productivity stagnation, inadequate technological application and low processing efficiency of animal byproducts and appropriation of value by market intermediaries at the cost of farmers. Livestock unlike farming rearing is less affected by weather conditions and thus provide dependable source of income to the farmers during lean agriculture period which provide fair amount of sustainability to the family. Vagaries of nature- no rains or excessive rains land the farmers in trouble and compel them to extreme action of committing suicide. Animal Husbandry activities through long-term and short-term; breeding programme will alleviate the sufferings of the farmers and help them go through the difficult situations by providing income.

Livestock in Maharashtra is an integral part of agriculture production system and plays an important role in the State's economy as well as in economic development of millions of rural households. A considerable part of Maharashtra is semi-arid and suffers from periodic drought and acute water stress. These parts of the State are in fact largely dependant on agriculture and recommend specific dry-land farming practices with water conservation measures along with livestock integration. Alternate intervention for example sheep and goat farming, grassland and pasture development using rain-fed and drought-tolerant grasses are the alternate alternative with environmental consideration.

It is well-known that livestock in Maharashtra is highly dependent on various forms of crop-livestock integrated mixed farming systems and common property resources. The cultivation of fodder and forage crops is low, and largely restricted to the irrigated tracts and peri-urban areas for dairy production. There are limitations for fodder and pasture development because of small fragmented lands. Over 80% of the land holdings are less than 2 h size. The priorities for production of agricultural produce are compelling. The lands under pasture and fodder development are less than 8 percent. The straws, crop residues and agricultural byproducts are the main sources of nutrients for the livestock. Small ruminants are mostly grazed with none or minimal stall-feeding.

There are certain areas also which are subject of very heavy rains and are covered with dense forest. Livestock rearing is difficult here as the forest poses dangers such as wild predators, ectoparsitic diseases. Livestock which are most suitable for this region are poultry, pig, goat and buffalo. Expensive breeds are difficult to maintain in these regions as they may easily succumb to disease or be consumed by wild predators.

Thus special livestock programmes need to be developed for these regions keeping in mind these constraints. Inspite of this, the State is bestowed with rich biodiversity which is a culmination of years of evolution with specific ecological and economic order. Farmers in order to survive and prosper, requires an urgent need to blend animals husbandry practices with Agriculture.

At present, the availability of milk in Maharashtra State is of 170 g per day per man. FAO/WHO recommended that the minimum requirement for milk is of 250 g per day per man. It is also much below the minimum requirement of 220g recommended by the Nutritional Advisory Committee of the Indian Council of Medical Research (ICMR). Regional imbalance of livestock development status in the State in the light of the eco-socio-cultural and technological changes occurring from time-to-time necessitates closer look for suitable modifications in the strategies. Most of the rural farmers search ways of breeding their animals to prevent economic losses. Although the milk production in Maharashtra has substantially increased during last thirty years, per capita milk availability is still lower than desired.

Perspective Plan for Livestock Development

The primary objective of any livestock enterprise is to achieve maximum production and profitability. This involves sound application of basic scientific principles to suit a particular situation which varies from country to country, region-to-region and from time-to-time. Livestock production involves integrated application of the principles of animal breeding, feeding, housing and diseases control in a manner suitable for particular situation. If livestock owner wants to enjoy financial security in this State with these prevailing conditions then he must operate on large-scale and a great deal of attention will have to be given to consumer needs, in type, amount and quality of products. We have to produce for the market need rather than as in the past, try to find the market for what we choose to produce. In Maharashtra, cow breeds like Gaolao, Deoni, Red kandhari, Khillar and Dangi need to be upgraded by genetic improvement through appropriate breeding methods including biotechnological innovations. Absence of specific strategy and programme for conservation of indigenous breeds, upgrading local breeds according to geographical region livestock research station are required to be established. Breeding policy is the main tool through which the milk production can be increased and as such required quality forage production for the better growth of the animals. The persistence of particular type of livestock under specific climatological conditions not only reflects its adaptability but also confirm its utility under multifaceted economy of that area. Since the results of breeding strategy directly affect the production efficiency, the effect of regional variation in environment coupled with other factors have greater impact on success of breeding strategy.

Goats are found all over the State even in high rainfall tract. Nearly 30 percent of the rural household keeps goats in Maharashtra. Goats are very important in the nutrition of the poor as they supply milk for the children of the house. Goat provides a substantial contribution to the diet of the citizens of the State being a major source of animal protein after milk and poultry products. President Dr. A. P. J. Kalam mentions in his book that by the year 2020 the demand for the mutton is likely to double its present availability. Another important consideration is that these animals largely survive on forages that would otherwise go waste and that they do not compete with man in their requirement for food. Specific programme for conservation of local breeds of goat like Osmanabadi and Sangamneri needs to be followed. Feed for goats is not a problem as the majority of the owners feed goats on weeds gathered during agricultural operations. About a third hires grazers to graze their goats on common lands. Some concentrates are fed during lactation. Housing is not a problem with goats as they are housed inside or near the owners hut. Sheep Rearing is concentrated in draught and semi-draught prone areas of State such as districts like Nasik, Ahmadnagar, Dhule, Satara, Pune, Sangli, Kolhapur, Solapur *etc.* but it is less in heavy rainfall areas like districts such as Ratnagiri, Sindhudurg, Thane, Raigad, Bhandara, Gandchiroli *etc.*

Poultry Industry is most dynamic and fast growing sector of our livestock economy but per capita consumption of egg and meet is very low. Reason for this is the growth of poultry enterprise based upon improved genetic stock inducing exotic germplasm, improved poultry health care with high degree of management only in urban and peri-urban area. Per capita availability of egg in the State is 33 eggs per person per year. National Nutritional Advisory committee has recommended availability of half egg per day per person. Rural poultry development will not only increase our per capita consumption but also will provide more number of employments to rural youths, improve incomes of rural households and improve nutritional status also. Government of Maharashtra intended to diversify in poultry farming by introducing Quail and EMU Farming. The Government of India has permitted farming of domesticated verity of Quail for commercial purpose keeping in view of its potential in this country. The employment in rural areas and production potential can be increased further by raising Japanese quail and EMU on commercial basis as it has started by many farmers in Maharashtra.

Dairy Business has become one of the most important and economically productive resources for farmers in Maharashtra. However, majority of Cattle and Buffaloes are non-descript, having low milk yield and long dry period. There is ample scope to improve on all the above mentioned factors and thus to improve the profitability of the diary farmers. Cross-breeding and upgrading programme is being rigorously followed for improving genetic make-up and productive traits. However, much efforts are needed in reducing long dry periods due to infertility.

Fisheries both marine as well as fresh water, offer tremendous potential for growth. The sector has been neglected. The key issues are careful planning, scientific breeding, making seeds available to the fishermen, especially in freshwater fish farming and combating disease and productivity problems. A major issue is the lack of modern diagnostic facilities. Secondly, non-formal training or education opportunities for those who are already engaged in fishery trade is lacking. Thirdly, marketing infrastructure with ensuring quality and safety would greatly enhance the aqua product consumption.

Small scale and marginal farmers can be helped by providing micro-finances for purchasing cattle, buffalo, goats, sheep and chicks. Over 70% of the landholdings are with the small and marginal farmers and landless families. These together hold about 50% of the livestock inspite of small land holdings and meager resources. The livestock production potential is under-utilized in such a situation and there is higher risk for potentially more productive animals. A farmer can generate an extra income from the non farm activity like raising 100 birds, 11 goats and a milch cow or buffalo, after paying the banks installments. Banks need not subsidize the interest rates but a three year moratorium would go long way in making these farm operations sustainable. Banks or government agencies should also give training to small and marginal farmers for developing non-farm activities. Banks or government may pay for premium to insurance companies for issuing farm animals to cover them for any outbreak of diseases which would reduce the chances of default. A farmer can hope to migrate to positive economy by these programmes. He can add substantially to his income, if he sells his produce directly to retailers, eliminating the middlemen. There is a need to encourage co-operative movement throughout the country for this purpose.

Strategic Approach

Proper livestock development will require co-ordination and planning between as diverse departments as water resources, agriculture, animal husbandry, forests, Panchayat Raj, tribal development, women and child welfare and watershed management. However, there is no clear inter-connectedness across the sectoral programme and in many cases one goes against the other. Although the livestock is usually dealt along with agriculture at Policy level, the integration of these two sectors is rarely found.

A comprehensive programme of breeding, feed and fodder production and conservations health

cover, animal insurance, marketing, establishment of agro-based industries, modern abattoirs, processing factories and greater quality control and implementation of biotechnology for breeding, better fodder production on small holding, will increase production and export potential. We have to generate interest among our rural youths for taking up livestock rearing and avenue for self-employment. This will reduce the problem of unemployment in rural areas and boost rural economy. This of course a step toward micro level planning based on the local conditions but there is need for national movement towards livestock development as an industry rather than a vocation at present.

Journal of Natural Resource and Development 2(1):83-90, 2007

ROLE OF VESICULAR ARBUSCULAR MYCORRHIZA IN ROOT DISEASE MANAGEMENT - AN OVERVIEW

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Mycorrhiza describes a range of symbiotic structures formed between fine roots of land plants and different fungi. In natural communities, approximately 70% of higher plants are obligatory dependent upon fungal associates, 12% being facultatively dependent and 18% being typically non-mycorrhizal. Fungi belonging to Endogonaceae are mostly involved in this type of mycorrhiza. In this extremely widespread mycorrhizal type the fungus not only grows intercelluary in the root cortex but also penetrates the host cell, forming 'vesicles' and 'arbuscules' within the roots. The vesicles store carban sources while the arbuscular facilitate transfer of soil nutrient, in particular phosphorus, from fungus to plant. The arbuscules is thus the key structure in symbiosis. The fungal endophytes improve host growth, health and resistant to biotic and abiotic stresses, the host plant in turn becomes a rich source of energy to the soil, the organism accelerate soil aggregate formation, and the life supporting soil structures thus formed facilitates better plant growth closing to chain.

Efficient strain of mycorrhiza is critical for harnessing better benefits from such symbiotic associations in the face of major biotic and abiotic challenges in the zone of root influence, establishment of inoculating mycorrhizal symbiont should be assessed. Above all, workable technology for appropriate delivery system of the mycorrhizal inoculum needs to be perfected for harressing fuller benefits.

The roots of many vascular plants other than conifers are extensively colonized by VA mycorrhizae which intercellularly penetrated cortical cells of the feeder root (Carling and Brown, 1982). The VA mycorrhizal fungi form large vesicles and arbuscules in the cortical tissues (Mosse, 1973) and these arbuscules are short-lived which survive for 4-15 days only (Bavege and Bowen, 1975). VA mycorrhizae are formed by most agricultural, horticultural and ornamental crops (Gerdemanh, 1975). VA mycorrhiza covers all woody species not included among the ectomycorrhizal families and many other herbaceous plants, legumes, grasses, tomatoes, apples, strawberries, peaches, orchids, coffee *etc.* which have considerable importance (Hacskayla, 1972). Recently VA mycorrhizal associations have been found for the first time in four species of Hawaiian ericales (Koske *et al.* 1990). Mercy *et al.* (1990) have evaluated cowpea genotypes of diverse origin for their VA mycorrhizal colonization as this colonization was not only host dependent but heritable as well.

At the global level there is a gradient of decreasing organic matter and increasing base status of soil towards the tropical and subtropical regions. This is associated firstly with increase in the proportions of trees in families such as Cupressacease which are host to VAM fungi at the expense of ectomycorrhizal families such as Pinaceae. Eventually the complete exclusion of the ectomycorrhizal habit takes place. In tropical and grassland ectosystems more rapid rates of mineralization of organic matter will contribute to the reduction of nitrogen limitation unlike in ericoid and ectomycorrhizal habitats. The VAM fungi appear to have little ability to mobilize nutrients from polymeric sources and as a group are much less physiologically diverse. Novertheless, they have increased access to phosphate due to their superior ability to exploit soluble and recalcitrant phosphates in soil they play a significant role in releasing this nutrient to their partners as phosphate becomes the most limiting nutrient under these conditions (Read, 1991).

A wide variety of reports in recent years have indicated a host plant previously inoculated with a mycorrhizal fungal symbiont exhibits increased tolerance to a range of root diseases, although some reports have indicated that such mycorrhizal infections may in certain situations promoted the development of plant disease. Promotion or suppression of plant disease as influenced by mycorrhizal colonization and subsequent development may ultimately be determined by several biotics and abiotics interacting forces involved in the pathogen-host-mycorrhizal system. Change in the soil environment particularly in terms of its nutrients and water status, appreciable affect the germination, growth, development and pathogenic behaviour of several microorganisms.

Inoculation of host plant with fungal symbionts have been shown to exert probiotic influence in the management of diseases like wilt and root rot. Growth of mycorrhizal seedling infected with *Phytophthora parasitica* was greater than that of infected nonmycorrhizal citrus seedling (Davis and Menge, 1981) which is in contrast to their earlier findings where the beneficial response of citrus to mycorrhizal infection was suppressed by the test pathogen at high inoculum density (Davis *et al.*, 1978). A lower initial inoculum density of the pathogen did not prevent mycorrhizal seedlings greater than of mycorrhizal ones which grew slowly because of their inability to absorb nutrients as effectively as mycorrhizal roots from absorbing more phosphorus and other nutrients than infected, nonmycorrhizal plants with mycorrhiza still functioning in seedlings. It is speculated that infection with mycorrhizal fungi elicits a resistance mechanism by the host which may suppress the subsequent infection by fungal pathogens. Jalali and Thareja (1981) while studying the impact of a mycorrhizal fungus on infection of chickpea by the wilt pathogen, *Fusariam oxysporum* f. sp. *ciceri*, indicated that inoculation with *Glomus* spp. resulted in extensive colonization of roots by mycorrhizal, and this was associated with significant reduction in the percentage of plants infected with *Fusarium* in those treatments which had been inoculated with the pathogen. Inoculation with *Glomus* also enhanced total dry matter production, nodule number and phosphorus gradient in those plants not infected by the pathogen. This suggests that mycorrhizal colonization may provide effective protection against infection with *Fusarium* and perhaps other root pathogens. Mycorrhliza refers to mutualistic, symbiotic relationship formed between fungi and living roots of higher plants. The VAM is the most common in occurrence among all mycorrhizal types (Mosse *et al.*, 1981). Its colonization with root tissues is conducive to efficient use of nutrients and water uptake by plants especially in infertile soils (Harley and Smith, 1983). Chickpea in one of the important pulse crop grown in India and is most compatible for the development of VAM association (Singh and Singh, 1995). VAM and *Rhizobium,* both have symbiotic relationship with chickpea. Islam and Ayanaba (1981) observed that inoculation with *Glomus mosseae* and *Rhizobium* increased the percentage of colonized roots, shoot dry matter and yield in cowpea under field conditions. Subba Rao *et al.* (1985) observed that dual inoculation with *Rhizobium* and *G. fasciculatum* resulted in increased N-fixation in chickpea as determined by the estimation of $^{15}N_2$ atomic percent excess by using labelled ammonium suphate in pot trials. Further Rai (1988) studied the interaction response of *G. albidus* and chickpea *Rhizobium* strains on iron uptake and symbiotic N_2 fixation in calcarous soil. It was concluded that inoculation with *G. albidus* strain IC-76 and *Rhizobium* increased seed P, Ca and Fe content.

Bader-El-Din Moawad (1988) reported that inoculation of VAM and *Rhizobium* induced significant increase in plant dry weight and seed yield in lentil and soybean. The association of VAM fungi with plant nematodes and the beneficial effect of mycorrhizal symbiosis on plant growth has led to investigations into the potential of VAM fungi to limit yield losses due to nematodes. Presence of VAM resulted in decreased population level of *Globodera solanacearum. Meloidogyne hapla* and *M. incognita* respectively (Sikora, 1979, Fox and Spasoff, 1972).

On seed inoculation of various legumes with yeast recorded higher VA mycorrhizal root colonization in pigeon pea as compared to other crops (Singh and Kapoor, 1989). When rice is inoculated with VAM mycorrhiza, Fusarial wilt disease can be controlled (Jalali, 1978). As the VA mycorrhizal spores on the roots of cotton and jute increase and the pathogenic fungi decreases (Bali *et al.*,1988). Inoculation of VA mycorrhizal to tomato root (Bagyaraj *et al.*, 1976) and cowpea (Jain and Hassan, 1988, Jain and Sethi, 1989) increases plant growth and reduces the damage caused by nematodes. The inoculation of mustard with *Glromus mosseae* is associated with higher uptake of phosphorus and its growth (Esther and Dube, 1988).

Early establishment of the mycorrhizal symbiont appeared to be vital if this microbial model system has to be employed effectively to manage root diseases. Recently, it has been conclusively demonstrated that inoculation with mycorrhizal endophyte *Glomus intraradices* alone or in combination with *Trichoderma harzianum* effectively reduced root rot caused by *Fusarium oxysporum* f. sp. *aspargi* when asparagus seedlings were grown in low levels of pathogen infested medium (Arriola *et al.*, 2000). They further showed that when seedlings were grown in high levels of pathogen-infested medium, the combination of *Glomus intraradices*+*T. harzianum* significantly increased dry shoot mass and limited root rot progression.

The single most common effect of VAM fungi on nematode susceptible plant is promoting tolerance to nematodes. Thus plants heavily colonized by mycorrhizal fungi are able to grow well inspite of the presence of damaging levels of plant parasitic nematodes. The interaction of VAM fungi and soil borne pathogens particularly plant parasitic nematodes has been extensively studies and reviewed (Hussey and Roncardory, 1982; Jain, 1986; Schenck *et al.*, 1975; Schonbeck, 1979, 1987; Smith, 1987). Many workers have demostrated a reduction in nematode population densities (Cooper and Grandison, 1986; Grandison and Copper, 1986; Jain and Hasan, 1988; Sikora and Schonbeck 1975) but cases where nematode population remain unaffected (Hasan and Jain, 1987; Jain and Hasan, 1988) or even increase (Atilano *et al.*, 1981) under the influence of mycorrhizal are hot uncommon. However, Saleh and Sikora (1984) suggested that these variations in the nematode population or infection level may be due to the differences in nematode-VAM host combination. They have further emphasised that each VAM-nematode-host combination is unique and not a subject of generalization, therefore, require studies of each combination.

Thus it appears that the endotrophic mycorrhizal fungus predisposes plants to several nematode species causing an increase in plant resistance or tolerance. The main prerequisit for predisposition appears to be the presence of mycorrhizal fungus in the plant root system prior to nematode attack. According to Sikora (1979) the fungal symbiont may exert its influence on the nematode by: (1) altering root attractiveness, (2) reducing larval penetration, (3) impeding larval development and (4) reducing giant cell formation. These effects most probably result from complex physiological changes associated with the mycorrhizal infection, rather than caused by direct competition between the two organism. In addition to this however, Smith (1987) has discussed some hypothetical mechanisms of increased tolerance or resistance against nematode in mycorrhizal plants which may by due to: (1) increased root growth and function, (2) nutritional effect other than P, (3) alteration in root exudation, (4) competition for space and (5) parasitism of eggs. Although these hypotheses were not all inclusive and also most were not supported by research data but they do offer a basis for discussion and future research. Thus it seems likely the VAM fungi do not directly interact with nematodes inspite of their proximity in root tissues. More likely, VAM fungi alter the host either physically or physiologically and thus indirectly affect the host-nematode relationship (Smith, 1987).

Endparasitic fungal bioagent VAM represented by the genus *Glomus*, in recent years has been provided to be very useful in the management of fungal, nematode and disease complexes. Similar observations have been made by Jalali and Thareja (1982), Singh *et al.*, (1990); Pandey (2002); Pant *et al.*, (2004) and Pandey *et al.*, (2005). *Glomus*

fasciculatum and *G etunicatum* expressed an ideal management component along with Karanj and mustard oil-seed cake for *M. incognita* in brinjal and tomato, respectively (Singh and Goswami, 2001; Bhagwati *et al.*, 2000).

In India, researches on VA mycorrhiza received attention in mid-seventies and over the years our knowledge on various dimensions of its impact on host growth and development has expanded appreciably. The research efforts have been broadly directed towards: ecological and taxonomical aspects, interactions with other microorganism (particularly nitrogen-fixing organisms as well as soil-born pathogens), side-effects of pesticides on non-target mycorrhizal systems and other allied aspects. Valuable research information has been generated at various centers, principally from Haryana Agriculture, University, Hisar; University of Agricultural Science, Bangalore; IARI, New Delhi; G.B. Pant University of Agriculture and Technology, Pantnagar; Delhi University; JNU, New Delhi; TERI, New Delhi; CDRI, Lucknow and other centers.

At Bangalore, Bagyaraj and his group reported the occurrence of VA mycorrhizal in cardamom, betlvine, pepper and in submerged aquatic plants for the first time in the tropics. A method for screening and selecting efficient fungal endophytes has been developed and field trials for inoculating crop plants have been carried out. They also reported the enhanced release of amino-nitrogen, total sugars, alkaline and acid phasphatases in the mycorrhizal roots. Their work has been ably summarized by Bagyaraj (1991). At IARI, work carried out by Tilak and his associates has clearly shown that dual inoculation of *Rhizobium* and mycorrhizal fungi with some plant growth-promoting rhizobacteria (PGPR), spore enhancement of *Glomus fasiculatum* in soil by amendments like composting materials and nutrients (Tilak, 1992). The groups at JNU and Pantnagar have, by and large, concentrated their investigations on various physiological aspects of VA mycorrhizal (Johri, 1992; Verma, 1995) while at DU, systematic work has been carried out taxonomical. In recent years, many other centers have evinced interest in mycorrhizal research and several initiatives have been launched accordingly to encourage basic and applied work. The ICAR, DBT, DST and other agencies have sponsored several projects to encourage in-depth investigations. The ICAR has also initiated networking of mycorrhizal pursuits. To accelerate pace, a mycorrhiza Network Asia was established at TERI in 1988, to promote interactions among mycorrhiza researches and strengthen research pursuits. The center is publishing a quarterly *Mycorrhiza News*, besides maintaining a mycorrhiza culture collection, center.

Plant health and productivity are rooted in the soil and the quality of soil depends on the variability and diversity of its biota which determine the structures that support a stable and healthy agro-systems (Doran and Linn, 1994). The importance of soil is now recognized not only as an agricultural resource base, but as a complex, fragile and yet dynamic system that must be protected as well as managed to ensure its long-term stability and productivity. The goals of sustainability in agriculture could be viewed broadly as 'maximum plant production with a minimum of soil loss. In this scenario of balanced agrosystem inputs and outputs, the relevance of mycorrhizal endophytes have been described as that of a fundamental link between plant and soil (Miller and Jastrow, 1994). They, in fact, have shown how the affinity between mycorrhizas and soil aggregaters vary with root characteristics, with the intensity of root colonization and with the root system. It has been demonstrated that the soil mycelium alone is able to bring about soil effects equivalent to those of roots while roots and fungi affect soil aggregation synergistically, though root and fungus effects are hard to separate.

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