

## Theme 3 : Improved production technologies for field, horticultural and aquatic crops

### 3.1 Standardization of production and multiplication technologies

#### 3.1.1 Effect of tillage and water management practices on soil and crop under rice wheat system of south Bihar

(A.R. Khan, S.S. Singh, L.K. Prasad, R.K. Batta and A. Rahman)

The experiment was initiated in 2003 and is continued for 4<sup>th</sup> year. Four treatments on summer tillage (Deep Summer Ploughing (DSP) every year, DSP in alternate years, DSP after 3 years and no DSP), two tillage treatments (Conventional tillage and Zero tillage (ZT)) and two moisture regimes (normal water supply and limited water supply) are being evaluated. In the fourth year (Kharif 2006), deep summer ploughed fields were puddled as per the treatment before transplanting. One more treatment of DSP in third year was introduced during April, 2006.

Root growth in wheat following DSP rice was studied at different stages. Due to DSP root growth in wheat also was found better under DSP (alternate year) treatment compared to the other treatments. Similarly, among secondary tillage treatments, Zero tillage with planking resulted in better root growth under DSP compared to NDSP plots (Fig. 10). The root area was highest in ZT planking with DSP followed by CT + puddling and ZT + planking with no DSP.

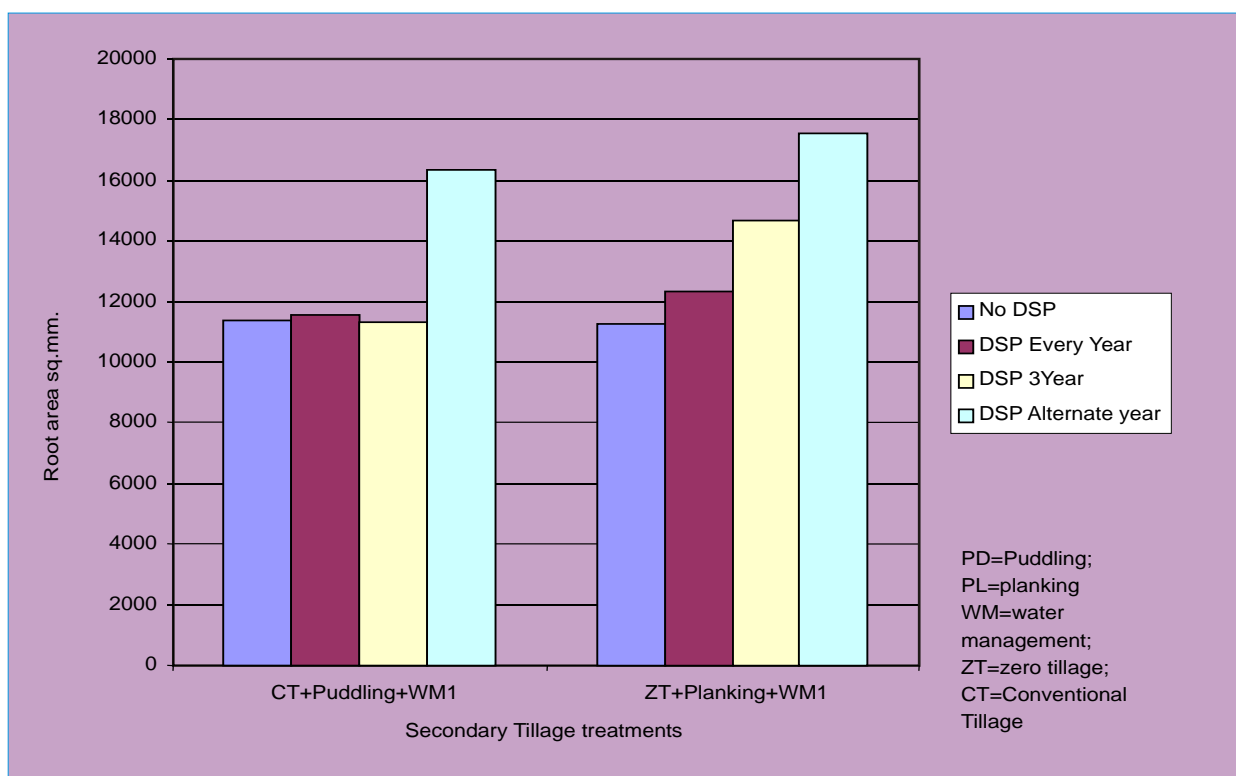


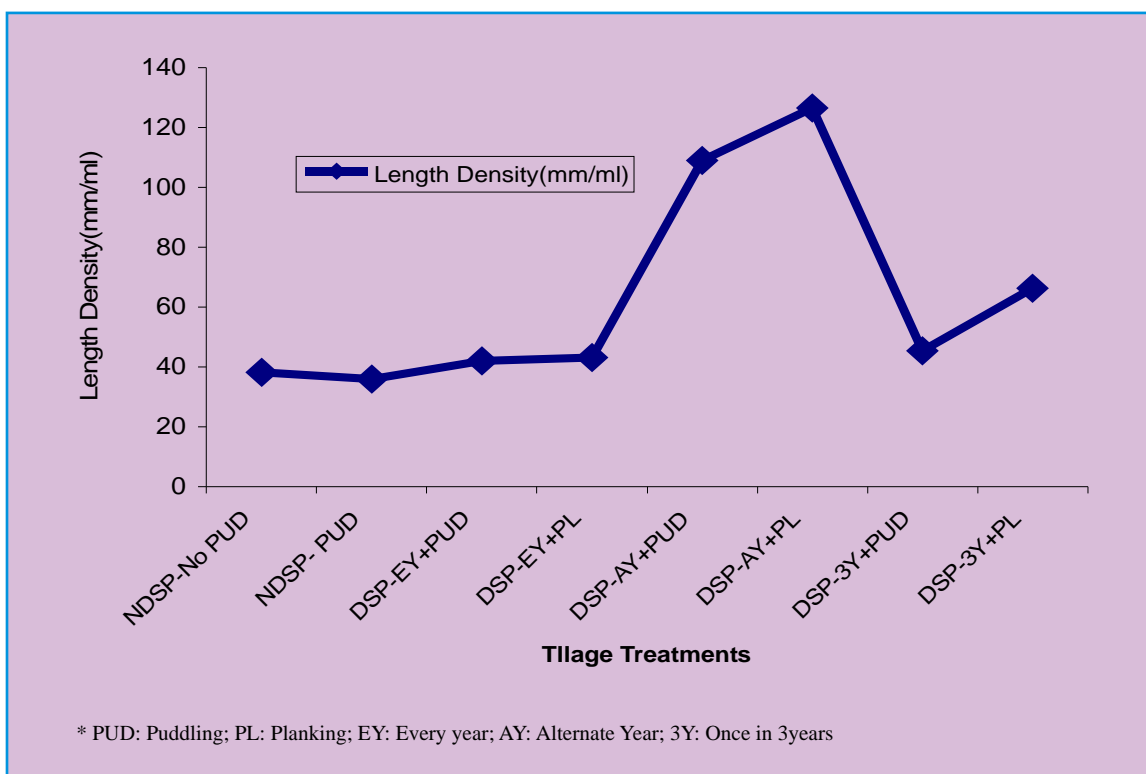
Fig. 10. Effect of deep summer ploughing and secondary tillage on root growth of wheat

DSP alternate year appears to be a better option of resource conservation than DSP every year. However DSP after 3 years produced highest grain yield (5.21 t/ha) and seems to be most economical because of less cost of DSP (Table 6). The yield of wheat in zero tillage was higher by 4-5 q/ha in all cases as compared to conventional tillage (Table.6).

DSP alternate and three years resulted in better weed reduction as compared to non-DSP. In both treatments, appearance of new flora of broad leaf annual weeds was observed probably due to breaking of dormancy of weed seeds lying in field for long time. In non-DSP field mostly perennial weeds like *Cyprus rotundas* (Motha) and *Cynodon dactilon* (Doob) were found. Zero tillage in wheat caused more incidence of broad leaf weeds as compared to conventional tillage in second year. There is however, less *Phalaris minor* incidence in zero tilled fields.

Table 6. Effect of tillage on yield attributes and yield of wheat in Patna (2005-06)

Tillage Treatment	Plant height (cm)	Weed dry weight (gm/m <sup>2</sup> )		No. of tillers/m <sup>2</sup>		Panicle length (cm)	1000 grain weight (gm)	Grain yield (t/ha)
		Tillering	Flowering	Tillering	Flowering			
<b>Summer tillage</b>								
DSP every year	84.95	39.95	25.73	366.50	735.00	14.32	39.97	4.74
DSP alternate	83.97	54.85	26.77	308.17	832.50	14.45	41.52	5.05
DSP 03 years	83.90	35.73	19.63	321.50	830.83	14.10	41.28	4.97
Non DSP	84.57	171.50	43.87	385.83	779.17	15.08	41.73	4.54
CD (P=0.05)	0.65	24.37	4.46	9.51	28.65	0.62	4.91	7.89
<b>Crop establishment tillage</b>								
Zero tillage	85.44	96.54	45.64	388.42	759.08	15.08	41.86	5.08
Conventional Tillage	83.25	54.03	12.36	302.58	829.67	13.91	40.39	4.57
CD (P=0.05)	0.52	5.28	3.30	13.19	29.41	0.39	NS	0.18



*Fig.11. Root Density of rice under tillage treatments*

Among the secondary tillage treatments along with DSP the practice of planking favoured better rice root growth compared to no DSP- no puddling treatment (Fig . 11). Nematode analysis of DSP and Non-DSP plots during July, September and at harvesting of rice indicates that plant parasitic nematode decreased more in DSP during July in comparison to non-DSP plots. The same trend was observed during previous year.

The growth and yield character in rice DSP at 3 year were found at par with DSP at alternate year and superior over each year. Due to seasonal variation, yield was less in all treatments than previous year. The water requirement in DSP was significantly less than No DSP. Under the influence of every year, DSP puddling was not found beneficial. Under DSP alternate and 3 years, both limited and normal water supplies gave equivalent grain yields, but significantly higher than the DSP every year. Highest yield was found at DSP 3 years with normal water supply and puddling. Under no puddling, limited water supply was found better yielder.

Based on the results, it can be inferred that DSP at each year is not needed and DSP after three years is better than alternate year. Puddling can be curtailed during DSP year and beneficial effect of DSP is achieved especially under limited water supply.

### 3.1.2 Development of sustainable production and utilisation in fruits and ornamental crops.

(R.V. Singh, Bikash Das, P. Dey, and I. Turkey)

#### Horti-silvi-pastoral system for uplands

The experiment is aimed at standardizing the suitable mango based cropping system for uplands of sub-humid regions of Eastern Indian Plateau. Performance of different filler and inter crops under mango based cropping system was evaluated. The mango plants attained the maximum trunk girth (67.0 cm) with intercropping of paddy. Among the filler crops, the guava plants attained the maximum canopy volume (17.16 m<sup>3</sup>) with intercropping of *Stylosanthes* while the maximum tree volume (13.1 m<sup>3</sup>) of citrus was recorded with intercropping of paddy.



Shading effect of gamhar plants (filler) on mango (main crop) could be observed after 8 years of planting

The *gamhar* plants attained maximum height with intercropping of paddy and shading effect of *gamhar* plants could be observed on the main crop (mango) after 9 years of planting. The maximum total paddy equivalent yield was recorded with Mango + Guava + French bean combination (7.29 t/ha). The density of weed under different inter crops ranged from 0.06

kg/m<sup>2</sup> (*Stylosanthes*) to 0.258 kg/m<sup>2</sup> (cowpea). Intercropping of paddy resulted in maximum content of soil organic carbon i.e. 0.43 per cent (Fig. 12).

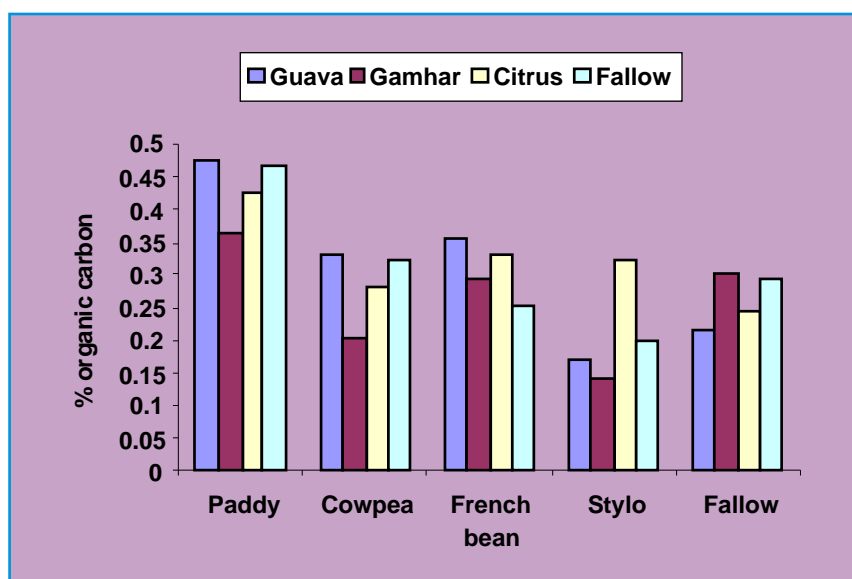


Fig. 12. Content of soil organic carbon under different mango based multi-tier cropping systems

## Standardization of aonla based cropping system for upland

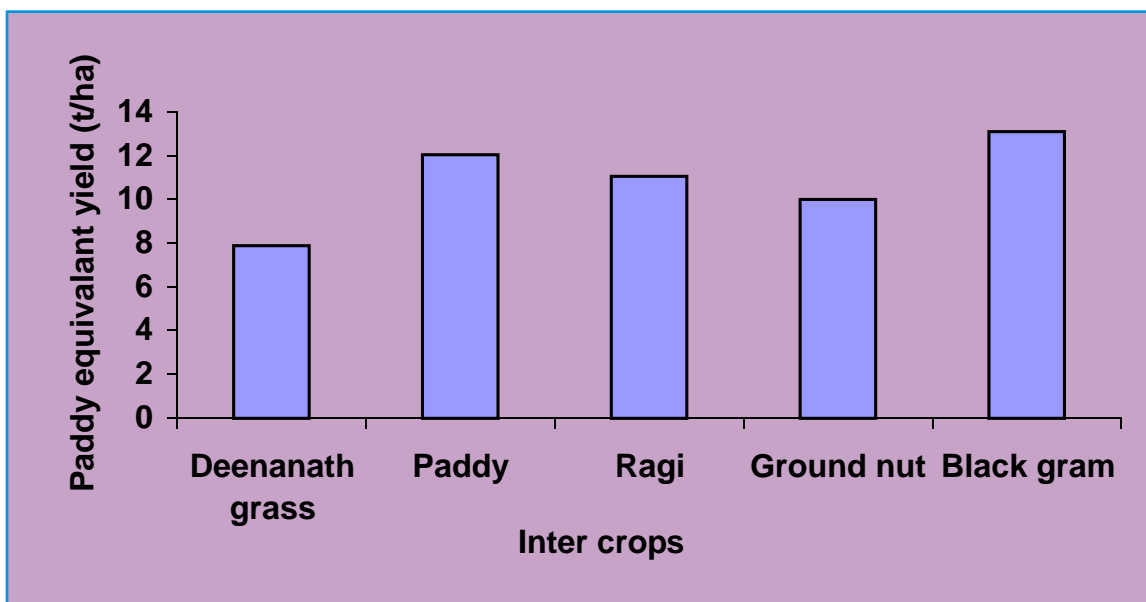
The experiment is being carried out to standardize the suitable aonla based multi-tier cropping system for uplands of sub-humid regions of eastern plateau. The treatments constitute cultivation of five



*Inter cropping of groundnut under aonla based multitier cropping system*

intercrops in aonla orchard having guava as filler crop. The maximum rate of increase in girth in case of aonla was recorded with ragi as inter crop whereas in case of guava, it was maximum in case of paddy intercropping. In both the cases the minimum rate of increase in girth was recorded in case of intercropping with ground nut. Intercropping of Deenanath grass resulted in the maximum rate of increase in canopy volume in case of aonla (16.2 per cent) whereas in case of guava the maximum value was recorded with intercropping of groundnut (138.5 per cent).

Intercropping of paddy resulted in maximum yield of aonla (8.71 kg/plant) whereas intercropping of black gram resulted in the maximum yield of guava (24.3 kg/plant). Intercropping of black gram under aonla based multi-tier cropping system with guava as filler crop resulted in the maximum total paddy equivalent yield (13.08 t/ha) (Fig.13). Intercropping of ground nut resulted in the highest soil organic carbon content (0.95 per cent) in the 0-15 cm soil layer.



*Fig. 13. Total paddy equivalent yield (t/ha) with different intercrops under rainfed aonla+guava based multi-tier cropping system*

---

### 3.1.3 Development of sustainable production and utilization of vegetable crops

*(Ranvir Singh, P. Dey and I. Tirkey)*

#### **Standardisation of mango (bearing) based intercropping cv. Langra**

The experiment was conducted for the seventh consecutive year with five intercrops viz. black gram, cowpea, French bean, paddy and turmeric in four replications. Black gram, cowpea, French bean and paddy severely suffered due to dense shade of mango (20 years old) trees. Turmeric planted in June, 2005 produced 4.14 t/ha paddy equivalent yield when harvested after 20 months as the crop was not harvested during the year 2006 due to poor recovery owing to insufficient precipitation. The net returns from turmeric intercropping were recorded as Rs 13,190/ha with a B:C ratio of 2.76. Growth characteristics of base fruit crop viz tree height, trunk girth and spread of canopy did not show any marked influence on intercropping treatments.



*Intercropping of turmeric with mango*

#### **Spacing and fertilization trial on pointed gourd cv. Swarna Alaukik**

Planting of pointed gourd at varying intra-row spacing showed marked influence on yield of fruits in the second year of experimentation. The maximum yield of 16.05 t/ha was recorded with 100 cm spacing though the differences were not significant. The yield and number of fruit from individual plant improved with the increase in nutrient area and the maximum values (2.1 kg and 99.7 per plant, respectively) were recorded with 150 cm intra-row spacing. The fruit quality characteristics viz. average weight, length, breadth and volume of fruit did not show any significant influence of varying plant spacing. Numbers of primary branches and girth of main stem showed positive response to increasing plant spacing.

Increasing the nitrogen level from 40 kg/ha to 120 kg/ha improved the yield of fruits in pointed gourd (12.13 to 17.03 t/ha, respectively). Average weight, length, breadth and volume of fruit and pulp and seed contents in fruit had no influence of graded levels of nitrogen. The number of primary branches improved with increasing N upto 120 kg/ha (13.96).

Phosphorus application beyond 30 kg/ha did not show any positive effect on yield and performance of individual plant in pointed gourd. Average weight, length, and volume of fruit remained unaffected. The maximum number of primary branches/plant was observed in the case of 90 kg P<sub>2</sub>O<sub>5</sub> but it was statistically at par with other treatments.

#### **Performance of sweet potato cultivars**

The trial with six cultivars of sweet potato viz. Pusa Safed, Gauri, Sree Bhadra, Sree Nandini, Samrat and Sankar was carried out with four replications during the year. The cultivar Sree Bhadra

---

---

recorded the highest total and marketable yields of tubers compared to all other varieties (12.17 t/ha and 9.38 t/ha, respectively) which was significantly more compared to Pusa Safed and Sree Nandini. Cultivar Sankar gave the next best total yield (9.90 t/ha) where as Samrat recorded the next higher marketable yield (7.32 t/ha). Similarly, the maximum total and marketable yields per plant were recorded with cultivar Sree Bhadra. Cultivar Sankar recorded the maximum number of secondary branches. The cultivar Sree Bhadra had significantly higher thickness of stem at base (0.6 cm).

### **Integrated nutrient management in bottle gourd**

Marked influence of different nutrition treatments was observed on yield and growth characteristics of bottle gourd cv Arka Bahar during the period of study. The application of poultry manure @ 2.5 t/ha and 30, 20 and 20 kg/ha NPK recorded the highest yield of marketable fruits (52.31 t/ha) followed by poultry manure alone @ 5.0 t/ha with (43.09 t/ha) but the differences were non significant. The least yield of fruit was recorded in case of vermi compost application @ 5.0 t/ha (28.44 t/ha). The maximum number of fruit per m<sup>2</sup> area was recorded with the application of poultry manure @ of 2.5 t/ha with 30-20-20 kg/ha NPK. The period required for opening of male and female flower did not show any significant influence of treatments.



*A crop of bottle gourd cv Arka Bahar*

Application of recommended doses of N P K (60-20-20 kg/ha) initially (at 30 days) influenced the formation of primary branches significantly which was observed at par at later stages of crop (60 days and 90 days of transplanting). The highest number of secondary branches/plant was observed with the application of poultry manure @ 2.5 t/ha and 30 kg N: 20 kg P<sub>2</sub>O<sub>5</sub>: 20 kg K<sub>2</sub>O/ha.

### **Isolation studies in bitter gourd**

The experiment with 5 isolation distances viz., 400, 600, 800, 1000 and 1200 m was carried out during the summer season of 2005. Seeds obtained from different treatments were again sown in the year 2006 for studying the extent of out crossing. The results showed no out crossing beyond 400 m isolation distance.

### **Enhancement of storage life of onion & chilli seed**

**Chilli :** The trial was carried out on fresh seeds of chilli cv KA-2 by imposing the treatments of NaCl, CaCl<sub>2</sub> and Parahydroxy benzoic acid with three concentrations viz., 10<sup>-4</sup>M, 10<sup>-5</sup>M and 10<sup>-6</sup>M during the month of May 2006. The treated seeds were stored at ambient conditions in cloth bags. The observations on germination were recorded every month by drawing the seeds from each sample. The results indicated that the seeds treated with NaCl at 10<sup>-4</sup>M to NaCl at 10<sup>-6</sup>M retained the maximum

---

---

viability after 8 months of storage under ambient conditions (86.3 to 87.6 per cent). Control showed the minimum percentage of germination after eight-month storage (66.2 per cent) amongst all the treatments.

**Onion :** The experiment was carried out with fresh seeds of onion cv Arka Niketan. The treatments consisting three concentrations viz.,  $10^{-4}$  M,  $10^{-5}$  M and  $10^{-6}$  M and three chemicals viz., NaCl,  $\text{CaCl}_2$  and Parahydroxy benzoic acid were imposed during May 2006. The seeds were then shade dried and stored at ambient conditions in cloth bags. The results showed that the application of  $\text{CaCl}_2$  at  $10^{-6}$  M had the maximum viability after eight months of storage (82.3 per cent) followed by NaCl at  $10^{-6}$  M and PBA at  $10^{-4}$  M (81.3 per cent). Control showed the least percentage of germination (55.6 per cent) among all the treatments.

### 3.1.4 Regulation of growth and development and nursery management of fruit crops

*(Bikash Das, B.R. Jana, P. Dey, S. Kumar, I. Tirkey, A.K. Singh, R.S. Pan and A.K. Tewary)*

#### Investigations on flushing, panicle emergence and fruit growth in litchi

The experiment is being conducted since 2003-04 to identify different plant phenological, morphological and biochemical parameters having higher correlation with panicle emergence intensity in litchi cv. Shahi under the Chotanagpur plateau conditions. Significant correlations were recorded during the last three years between intensity of panicle emergence and time of emergence of second and third flush, vigour and number of leaves in second flush and content of carbohydrate, phenol and tryptophane in the shoot. During 2006-07, efforts were made for validation of the correlations recorded during the previous year. During 2006-07, a higher rate of panicle emergence could be recorded under Ranchi conditions, which ranged between 40 to 95 per cent. The values of intensity of panicle emergence could not be explained based on time of emergence of second flush as against the correlations observed during the previous seasons. However, the emergence of panicles from 100 per cent of the shoots having third flush emerged during December was in conformity with the correlations recorded during the previous seasons. Significantly positive and similar correlations of intensity of panicle emergence could be recorded with shoot diameter of second flush (0.448) and content of tryptophane in the previous season growth of the shoot measured during the last week of November (0.451).

The sub-experiment on characterization of fruit growth is being conducted to develop an understanding of the relationship between fruit growth and source tissues (shoot). Litchi fruits of cv. Shahi exhibited a sigmoidal growth pattern with a phase of rapid growth during 40 to 60 days after fruit set. The content of carbohydrate accumulation in fruits exhibited a concave growth pattern with a rapid accumulation phase after 60 days of fruit set. The fruit retention



*Source limitation through leaf removal in litchi*

---

---

capacity in a panicle is a function of the strength of source tissue to support the carbohydrate demand of the growing sink (fruits). Induction of source limitation by girdling is an effective tool for studying source-sink relationship in fruit crops.

In the present investigation, irrespective of method or distance of source limitation, the maximum per cent fruit drop was observed when the source limitation treatments were imposed 30 days after fruit set which indicated the criticality of the stage of fruit growth (30 days after fruit set) with respect to dependency on source. Irrespective of date and method, source limitation at all the distances resulted in significant increase in per cent fruit drop over that with no source limitation in the whole plant. This indicated existence of mechanism for fulfillment of carbon requirement of growing fruits (sink) through mobilization from other part of the plant in absence of any source limitation in litchi. With respect to different treatments, girdling with leaf removal resulted in maximum fruit drop.

Estimation of correlation between bunch weight and number of leaves in different zone of the shoot below the bunch indicated maximum correlation in case of number of smaller leaves in the upper 0-30 cm below the bunch (0.775) followed by number of leaves in 60-90 cm zone (0.552). The results clearly suggest contribution of carbohydrate from current photosynthesis for partial fulfillment of total carbon demand of growing fruits.

### **Regulation of rainy season crop for sustainable guava production**

The experiment is being carried out since 2004-05 to standardize the method of regulation of rainy season crop for sustainable guava production under Chotanagpur plateau conditions.

Under the sub-experiment to standardize foliar application of chemicals for removal of rainy season crop, application of 2 per cent potassium iodide resulted in maximum removal of rainy season crop in guava cultivars Lucknow-49 and Allahabad Safeda under both irrigated as well as rainfed conditions. In both the cultivars foliar spray of chemicals resulted in reduction in the values of per cent increase in trunk girth than that in control. In cv. Lucknow-49, foliar application of potassium iodide followed by NAA (200 ppm) resulted in the maximum fruit yield of winter season crop under both irrigated as well as rainfed conditions whereas in cv. Allahabad Safeda, foliar application of NAA (100 ppm) resulted in the maximum winter season crop.

Under the sub-experiment to standardize level of removal of rainy season crop, in case of cv. Lucknow-49, the maximum yield of rainy season crop per trunk cross-sectional area was recorded with 25 per cent crop removal whereas in case of cv. Allahabad Safeda, the treatment effects were not significant. With respect to winter season crop, 100 per cent crop removal resulted in maximum yield per  $\text{cm}^2$  trunk cross-sectional area in both the varieties under rainfed as well as irrigated conditions. The maximum total yield per plant was recorded with 25 per cent crop removal in case of cv. Lucknow-49 under irrigated conditions whereas the treatment effects were not significant under rainfed conditions. In case of cv. Allahabad Safeda, the minimum total yield was recorded in 100 per cent crop removal both under rainfed as well as irrigated conditions. The profitability of the treatments was estimated by calculating the net increase in income over the control plants after deducting the cost of imposing the treatments. In case of the cv. Lucknow-49, the maximum profitability was recorded with 50 per cent and 100 per cent removal of rainy season crop under irrigated and rainfed conditions, respectively. In case of

---

cv. Allahabad Safeda, the maximum profitability was recorded with 100 per cent removal of rainy season crop followed by 50 per cent removal of rainy season crop. Under rainfed conditions, 50 per cent removal of rainy season crop recorded the maximum profitability followed by 100 per cent removal of rainy season crop. Hence, based on three years performance, manual removal of 50 per cent of rainy season crop was found promising for increasing the profitability of guava under Chotanagpur plateau conditions.

Under the sub-experiment to standardize foliar application of micronutrients and growth regulators for quality improvement of rainy season crop, none of the treatments resulted in improvement of quality in terms of average fruit weight, TSS, titratable acidity, content of reducing sugar in both the cultivars viz. Allahabad Safeda and Lucknow-49. In case of Lucknow-49, all the treatments except T<sub>1</sub>, T<sub>2</sub>, T<sub>9</sub>, T<sub>10</sub> resulted in significant increase in the content of total sugar in the fruit. Foliar application of NAA(20 ppm) resulted in maximum improvement in the content of total sugar in the fruit of rainy season crop.

### **Standardization of pruning in guava**

The experiment is being carried out to standardize the pruning requirement in guava cv. Allahabad Safeda under the eastern plateau and hill region. The treatments consist of pruning under irrigated and unirrigated conditions (A), pruning of different levels of canopy (0 per cent, 50 per cent and 100 per cent) (B) and pruning at three different shoot lengths (25cm, 50cm, 75cm) at three different dates (at 20 days interval starting 10<sup>th</sup> March). During the first year of experimentation, irrespective of level of irrigation and length and date of pruning, the number of fruits per cm<sup>2</sup> trunk cross-sectional area during rainy season declined with increasing the level of plant canopy under pruning treatment. No significant effect of any treatments could be observed during the winter season. As in case of fruit number, the yield per cm<sup>2</sup> trunk cross-sectional area of rainy season crop declined with increasing the level of canopy under pruning treatment irrespective of irrigation level or length and date of pruning. The yield of winter season crop was not influenced by any of the pruning treatments. The pruning treatments resulted in significant changes in different plant growth parameters.

### **Standardization of rejuvenation of unproductive mango plants of cv. Amrapali**

The experiment was initiated during December, 2005 with an objective to standardize the height of rejuvenation pruning and canopy architecture for improving productivity of 25 years old mango plants of cultivar Amrapali planted at a spacing of 5.0m x 5.0m. In the first phase, rejuvenation pruning was done at three different heights viz. 1.0 m, 1.5 m and 2.0 m and observations were recorded on pattern of vegetative growth and flowering under the three treatments. The earliest sprouting of bud was recorded in case of pruning at 2.0 m height whereas pruning at 1.0 m height resulted in delayed sprouting. After one year of pruning, the maximum shoot girth was recorded with 2m-height pruning, which was at par with that in case of pruning



*Standardization of rejuvenation and canopy architecture of Mango cv. Amrapali*

---

---

at 1.5 m height. Rejuvenation pruning resulted in increased frequency of flushing under all the treatments. Pruning at 2.0 m height resulted in production of 9.07 numbers of flushes in one year, which was significantly higher than that in case of pruning at 1.0 m height (8.19). Rejuvenation pruning at all the three heights resulted in initiation of flowering after one year.

### **Characterization of plant growth processes in pear in relation to flowering and fruit setting**

A study on yield and biochemical analysis of pear in different treatments was conducted. It was found that the maximum yield (10.63 kg/plant) was obtained from doubled spray of thiourea 10 per cent. The maximum fruit weight of 256 gm was obtained from three times spray of GA3 200 ppm. Three times sprays of thiourea 10 per cent recorded maximum TSS of 11.4<sup>0</sup>B. A single spray of H<sub>2</sub>O<sub>2</sub> 6 per cent showed the maximum acidity of 0.19 per cent. The maximum reducing sugar of 5.23 per cent and total sugar of 6.54 per cent were recorded from two times sprays of thiourea 10 per cent.



*Profused flowering in pear with spray of 10 per cent thiourea*

Harvesting of pear was done at 5 different times with 15 days interval. It was found that optimum maturity time was 10-07-06 when fruit weight was maximum (245 g). The maximum acidity of 0.19 per cent was found when fruit was harvested on 10-06-06. It was found that reducing sugar was increasing and total sugar decreasing gradually towards maturity.

### **3.1.5 Standardization of soil and water management in horticultural crops**

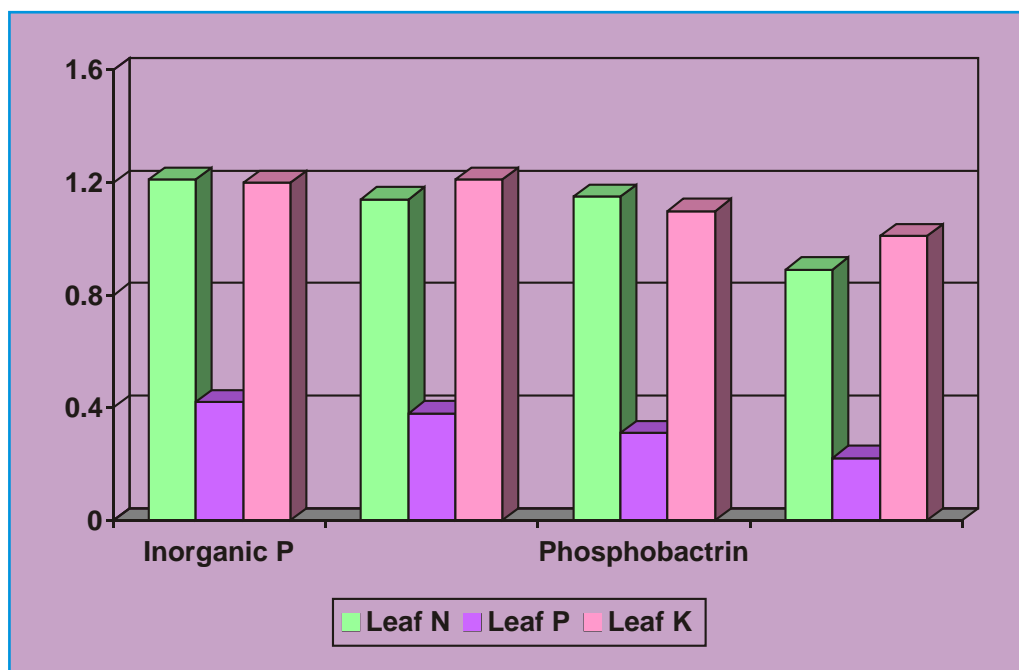
*(P. Dey, Bikash Das, R.V. Singh and I. Turkey)*

#### **Effect of major nutrient in guava**

Highest fruit weight (142 g) was obtained with the incremental application of 125 g N, 200 g P and 87.5 g K/tree/year. Highest acidity (0.15 per cent) was obtained by incremental application of 250 g N, 50 g P and 175.0 g K/tree/year. Highest TSS (10.4<sup>0</sup>B) was obtained by incremental application of 250 g N, 200 g P and 175 g K/tree/year. Maximum rainy season yield was recorded with incremental application of 125 g N, 200 g P and 87.5 g K/tree/year. In different treatments, leaf N content varied between 1.9 to 2.8 per cent N, 0.18 to 0.51 per cent P and 1.45 to 1.78 per cent K.

#### **Effect of organic and inorganic sources of phosphorus on air-layered plants of litchi**

Highest root length was observed with the application of inorganic P followed by VAM treated air-layers. Root weight was found to be increased by more than two-and-a-half times due to application of inorganic P. Root-bit colonisation increased by more than three-and-a-half times with the VAM inoculation. P level in leaf was found to be about double in treated than untreated air-layer; variation in N and K was, however, narrow (Fig.14).



*Fig.14. Variation in leaf nutrient content*

### **Residual effect of root pruning-cum-fertilizer application in litchi**

After three years of significant residual effect of root exposure, the effect of root exposure was found to peter off. Leaf nutrient compositions of treated and untreated plants were also negligible. Leaf N, P and K were found to be 1.08 per cent, 0.25 per cent and 1.14 per cent in treated plants, whereas corresponding composition for untreated plants were 1.01 per cent, 0.24 per cent and 1.12 per cent, respectively.

### **Changes in soil characters in different horticultural production systems**

Two horticulture based production system *viz.*, litchi and mango was studied. Among physico-chemical properties, pH, organic C, P and K and bacterial and fungal colonies were studied. It was observed that organic carbon, phosphorus, potassium and bacterial population was higher in litchi where straw mulching was done. Fungal population, however, followed a reverse trend. Intercropping in mango cv. Malda resulted in higher pH. Phosphorus, however, followed a reverse trend and intercropping resulted decrease in phosphorus content in soil.

### **3.1.6 Management strategies for maximization of productivity of water bodies through makhana based integrated aquaculture farming system.**

*(B.K.Jha, Janardan jee, D.K.Kaushal and L.K.Prasad)*

Twenty numbers of farmers ponds were identified and selected in Darbhanga district for on-farm experiment. The treatments comprising of T<sub>1</sub> (makhana cultivation alone); T<sub>2</sub> (after makhana, fish cultivation); T<sub>3</sub> (makhana-cum-fish cultivation); T<sub>4</sub> (makhana-cum-fish and after harvest of makhana, again fish integration) and T<sub>5</sub> (makhana-cum-fish and after harvest of both, again fish integration) were laid out in replicated manner in these ponds.

---

---

### Pond's soil characteristics

Soil pH of selected ponds varied from 6.84 to 7.83, representing neutral to slightly alkaline conditions, electrical conductivity varied from 0.03 to 0.15 dS/m indicating normal soil conditions without any salt accumulation whereas organic carbon content (per cent) ranged from 0.35 to 2.50 (Table 7). The higher values of organic carbon are due to accumulation and decomposition of makhana plant residues at pond bed over the years. The available nitrogen content of the soils varied between 408 kg/ha to 684 kg/ha with most of the soils in high category. The available phosphorus content of the soils varied between 28.6 kg/ha to 48.4 kg/ha suggesting that most of the soils are in medium category whereas available potassium content of the soils varied between 154 kg/ha to 366 kg/ha.

The dissolved oxygen showed depletion from May to August as the gigantic leaves of makhana covered the surface of water body and after harvest of makhana it showed increasing trend.

**Table 7: Chemical characteristics of soils of selected makhana ponds**

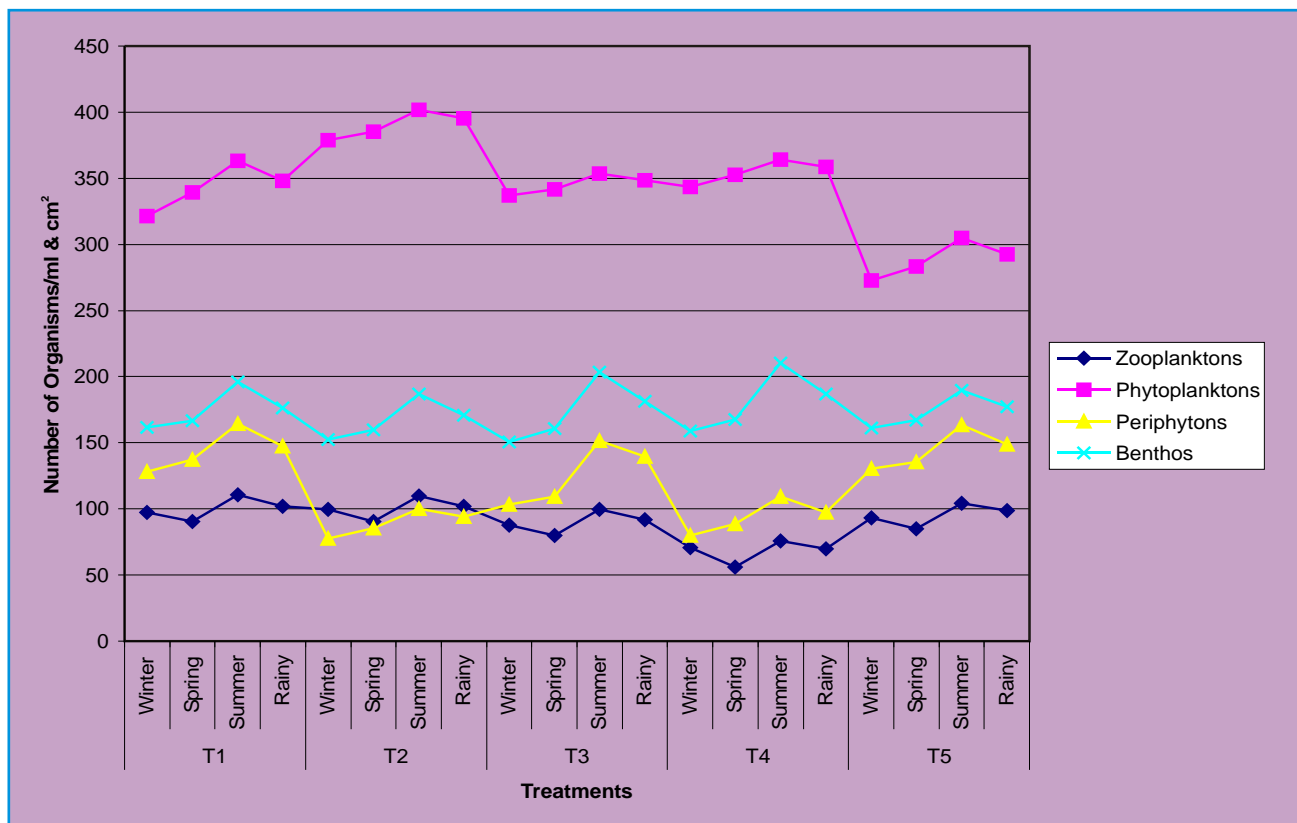
Ponds	pH	EC (dS/m)	Organic Carbon (per cent)	Av.Nitrogen (kg/ha)	Av.Phosphorus (kg/ha)	Av Potassium (kg/ha)
1	7.30	0.11	1.60	457.0	36.4	366.0
2	7.28	0.06	1.64	470.0	32.6	364.0
3	7.83	0.04	0.78	454.0	28.6	159.6
4	6.98	0.05	0.74	674.0	44.2	263.2
5	6.97	0.05	1.95	670.0	38.5	308.0
6	7.21	0.05	0.35	408.0	41.3	170.8
7	7.25	0.08	1.21	784.0	48.4	358.0
8	7.31	0.11	2.32	754.0	32.4	334.0
9	6.99	0.04	2.18	667.0	44.5	308.0
10	7.17	0.09	1.60	654.0	36.6	362.0
11	6.85	0.03	2.04	658.5	34.8	302.5
12	7.37	0.06	1.17	683.0	42.2	215.6
13	7.00	0.08	2.30	584.0	43.6	406.0
14	7.49	0.15	0.84	674.3	38.2	218.4
15	7.56	0.11	1.66	663.0	42.4	322.0
16	7.25	0.07	2.50	684.0	40.2	224.0
17	7.03	0.04	1.91	667.0	36.2	154.0
18	7.17	0.07	1.29	627.2	34.6	274.5
19	7.25	0.11	0.86	674.3	32.2	221.2
20	7.49	0.10	0.74	451.0	33.8	263.2

---

---

## Studies on biotic communities

The total population density of zooplanktons, phytoplanktons, periphytons, and benthic organisms treatment wise in four different seasons *viz.*, winter, spring, summer and rainy have been recorded. The biological characteristics of makhana ponds indicate a rich diversity of phytoplanktons, periphytons, zooplanktons and benthic organisms. Maximum and minimum ranges of mean population density of biotic organisms of treatments in four seasons as depicted in Fig.15 revealed that phytoplankton varied from 272.5 to 401.63 /ml; periphyton from 77.75 to 164.25 /cm<sup>2</sup>; zooplankton 56.2 to 110.45/ml and benthos 107.25 to 203.25/l respectively. The population density of phytoplankton was found maximum during summer, followed by rainy season, spring season and winter season. A more or less similar result was observed in case of periphyton and benthos. Zooplanktons showed maximum population density in summer followed by rainy and winter season and minimum in spring season.



**Fig. 15. Population density of biotic organisms in different seasons of treated ponds of makhana**

Altogether 105 species of phytoplanktons, 43 species of periphytons, 40 species of zooplanktons and 15 species of benthic organisms were recorded from twenty Makhana ponds of Darbhanga. The phytoplanktonic species was dominated by green algae including desmids (59 species), followed by blue green algae (27 species), Diatoms (18 species) and Xanthophyta (one species). Among periphytons, Diatoms included 16 species, followed by Desmids (8 species), Chaetophoraceae (2 species) and Cladophorales (one species). The zooplanktons included Coleoptera (4 species), Plecoptera, Hemiptera,

Odonates, Isopods, Flatworms (one species each), Cladocera (5 species), Rotifers (6 species), gastropods (3 species) and Copepods and Protozoans (2 species each). The fish fauna included minor carps viz., viz., *Puntius sophore*, *Esomus dendricus* and *Oxygaster bacaila* and air breathing Teleosts viz., *Channa punctatus*, *Channa. gachua*, *Clarias batrachus*, *Heteropneustis fossilis*, *Anabas testudineus*, *Trichogaster* species and *Gambusia affinis*. The major benthic organisms of makhana ponds were arthropods (10 species), molluscs (5 species) and nematodes.

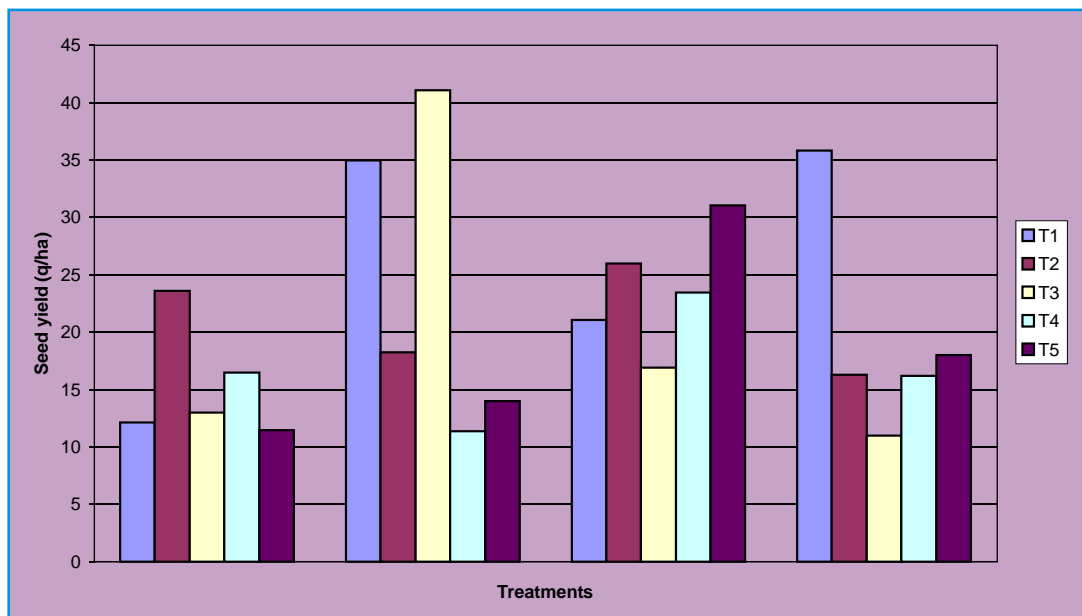
Among *Phytoplanktons*, *Oedogonium*, *Ulothrix*, *Cladophora*, *Tetraspora*, *Volvox*, *Oscillatoria*, *Nostoc* and *Plnnularia* were recorded from all the twenty ponds selected for present investigation; *Fragilaria*, *Bacillaria*, *Cladophora*, *Closterium* and *Cosmerium* among periphyton whereas *Cybister*, *Apple snail*, *Daphnia*, *Colpoda* and *Acanthamoeba* were recorded in all ponds among Zooplanktonic. Similarly, *Chironomous*, *Bactis*, *Chaetogaster*, *Lymnaca* and *Pila* were found most common benthos in all such ponds.

### Makhana-cum-fish integration

A refuge covering 10 per cent area of net water bodies as a central vacant space was created in Makhana ponds. The carp fingerlings were integrated in the refuge area of the Makhana pond in the first week of April. At the time of integration average weight of fingerlings of Rohu and Common carp were 10-18 g. As per the treatment fingerlings were again integrated in the same average weight in the month of September after harvest of makhana.

### Makhana and fish yield

In the first week of September makhana seeds were harvested from the bottom of ponds in three phases and total yield ranged from 1.69 to 2.60 t/ha among different treatments (Fig. 16). The treatment T<sub>1</sub> (makhana alone) showed maximum yield of 2.60 t/ha followed by T<sub>2</sub> (2.10 t/ha), T<sub>3</sub> (2.05 t/ha), T<sub>5</sub> (1.86 t/ha) and minimum in T<sub>4</sub> (1.69 t/ha) respectively.



*Fig.16. Seed yield of makhana of different treatments of makhana ponds*

---

Fishes harvested in the month of September after harvest of makhana recorded an average weight of Rohu 245 g and Common carp 455 g whereas fishes harvested in the month of December recorded average weight of Rohu (*Labio rohita*) 418 g and Common carp (*Cyprinus carpio* Linn.) 720 g, respectively. The fish yield in makhana-cum-fish integration showed a range of 0.11 t/ha to 0.27 t/ha. The treatment T<sub>2</sub> (after makhana-Fish cultivation) recorded a maximum yield potential of 0.3 t/ha followed by T<sub>4</sub> (0.27 t/ha).



*Rohu harvested from makhana - cum-fish on-farm trial*



*Common carp successfully harvested from makhana-cum-fish trial from farmer field*

Among all the treatments, maximum net profit of Rs.32,500/ha was recorded in T<sub>4</sub> followed by T<sub>2</sub> (Rs.32,600/ha); T<sub>1</sub> (Rs.28,500) ; T<sub>3</sub> (Rs.28,300) and T<sub>5</sub> (Rs.27,000) respectively. The integration of fish culture with makhana farming thus offers greater efficiency in resource utilization and provides additional food and enhances income to the makhana growers.

### **Yield potential of makhana-cum-fish station trial**

An effort was initiated for evaluation of yield potential of makhana cum fish in a newly excavated pond at Research Centre for Makhana, Basudeopur Farm. Fingerlings of carp were integrated with makhana in the refuge area in April. The average weight of Rohu and Common carp at the time of integration was of 15- 20 g. Makhana was harvested in the month of September and fishes were harvested in the month of December. The average yield of makhana seed in the makhana cum fish trial was 0.33 t/ha and fish yield of 0.42 t/ha. The average weight of fishes harvested in the month of December recorded 127 g & 167 g of Rohu (*Labio rohita*) and Common carp (*Cyprinus carpio* Linn.) respectively.



*Harvesting of Carp fishes (Rohu and Common carp) in makhana-cum-fish trial at Research farm of Makhana, Darbhanga*

---

---

### Germination and growth of makhana (*Euryale ferox*)

Systematic and scientific experiments on makhana (*Euryale ferox*) are being conducted at the lab and in field condition for generating information on establishment, growth and morphogenesis of *Euryale ferox*. An innovative attempt to germinate the seed under ex-situ condition was attempted and further seedlings were transferred in the polybags for domestication of the crops to overcome the traditional way of its cultivation.



*Germination of makhana seeds*



*Makhana after germination*

### Maintenance of germplasm in aquatic-cum-makhana gene bank

Successfully established the aquatic-cum-makhana gene bank at Research Farm in which collection of makhana (*Euryale ferox*) and other aquatic species e.g. *Trapa bispinosa*, *Nelumbo nucifera*, etc. are at present maintained.

### Effect of light and photoperiods on seed germination behaviour of makhana

Experiments were conducted to elucidate the effects of different light spectra viz., blue, green, yellow, red, white, dark and far red and photoperiods of 5,10,15,20,25,30 and 35 hours on the germination behaviour of the seeds of makhana. The results showed that among different light spectra, blue light was found to be the most effective in promoting germination (86.6 per cent) whereas far red inhibited the germination of seeds. Germination performance was similar in yellow and white light (70 per cent). In red and green light the percentage of germination was found to be relatively low i.e., 56.6 per cent. A more or less similar result was obtained in dark (50.3 per cent). Among different photoperiods maximum germination (90 per cent) was observed in 25 and 30 hrs of exposure of light. However, 35 hrs light exposure reduces the germination and recorded minimum of 20 per cent germination. The present result indicates that the seed of makhana germinated in all light spectra even in complete darkness, except far red light and higher photoperiods of 35 hrs reduces seed germination.

---

---

## 3.2 Integrated nutrient management

### 3.2.1 Long-term manurial trial on tobacco mono-culture (fallow-tobacco) systems.

Results revealed that an increased response was obtained in case of leaf area up to the extent of 63 per cent under irrigated condition (30<sup>th</sup> and 60<sup>th</sup> DAP) over rainfed crop; resulting into 25.4 and 20.4 per cent higher total and first grade leaf yields respectively. Application of N, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O each @ 112 kg/ha increased total cured as well as first grade leaf yields under irrigated condition.

### 3.3.1 Standardization of integrated disease management of fruit crops

(S. Kumar, J. P. Sharma and Bikash Das)

#### Management of guava wilt

**Varietal screening against guava wilt :** out of 27 varieties screened, the variety Hafsi (3.4 per cent), Chittidar (3.4 per cent) and S. Ruby (6.7 per cent) showed least incidence of guava wilt than other varieties during the year under report.

**Biochemical composition of plant tissues in different guava genotypes with respect to their susceptibility to guava wilt :** Efforts were made to study the different biochemical parameters among the guava genotypes and identify a suitable biochemical marker for screening of guava genotypes against wilt. Significant differences among the genotypes were observed with respect to the content of total soluble protein in roots and total phenol and total free amino acids in leaves.

**Management of guava wilt by use of bio pesticide :** The experiment conducted for management of guava wilt by application of fungal antagonist *Aspergillus niger* (Kalisena) revealed higher per cent of plant survival (86.0 per cent) in the 8<sup>th</sup> year of trial as compared to untreated one (68.0 percent). Application of *A. niger* (Kalisena) was also found to improve the plant vigour during the year under report. (Fig. 17)

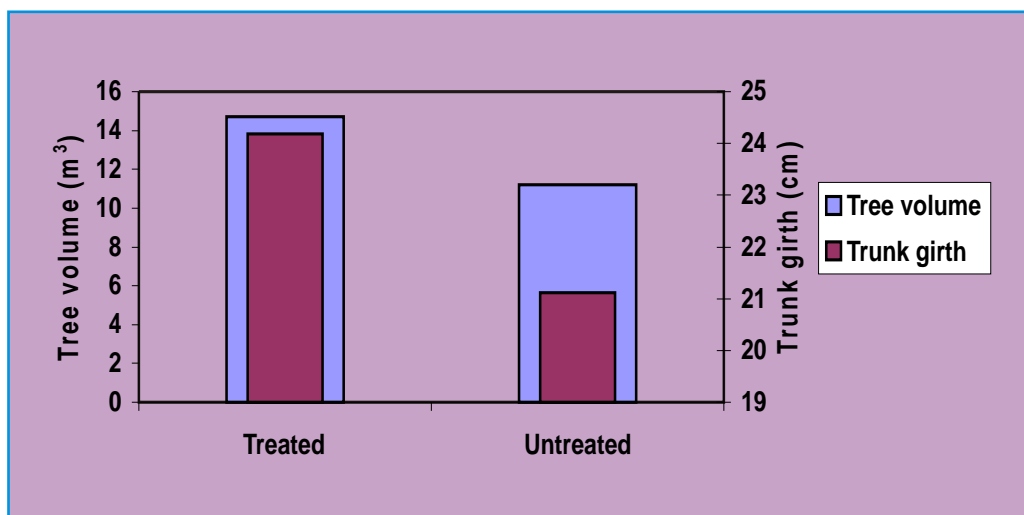


Fig 17. Effect of soil application of *Aspergillus niger* on vegetative growth of guava plants

---

---

### **Characterization of biochemical changes in guava twigs in response to *in vitro* culturing in crude culture filtrate of *Fusarium oxysporum* and *Aspergillus niger***

The investigation was carried out to characterize the different plant biochemical responses occurring in guava plant tissue as influenced by the interaction of the pathogen (*Fusarium oxysporum* f. *sp. psidi*) and fungal antagonist (*Aspergillus niger*) under *in vitro* conditions. The present study on changes associated with biochemical composition of leaves due to inoculating of twigs in different concentrations of crude culture filtrate indicated significant increase in the content of total soluble protein in leaf over control, when dipped in 100 per cent strength broth extract of the fungal antagonist *Aspergillus niger* whereas the change was not significant in case of 50 per cent strength. In case of inoculating the twigs in broth extract of *Fusarium oxysporum*, no significant change in the content of total soluble protein over the control could be observed.

The total free amino acid increased significantly over control in case of inoculating the twigs in both crude culture filtrate at 50 per cent and 100 per cent strength. However, a perusal of data on per cent increase in the content of total free amino acids over that in control indicated markedly higher per cent of increase in case of culture filtrate of *Fusarium oxysporum* than that of *Aspergillus niger*. The total phenol in the leaf increased significantly over control when the twigs were dipped in broth extracts of *Aspergillus niger* and *Fusarium oxysporum*. In case of *Aspergillus niger* higher content of total phenol was observed in case of 50 per cent strength of broth than that of 100 per cent strength while in case of *Fusarium oxysporum*, the content increased significantly with increasing strength of the culture filtrate.

### **3.3.2 Standardization of integrated disease management of vegetable crops and development of mushroom production**

(J. P. Sharma, S. Kumar, P. Dey, and Bikash Das)

#### **Integrated management of *Ralstonia* wilt using karanj cake, green manure by increasing population of *Trichoderma* in tomato**

The experiment was conducted in post monsoon season to standardize the dose of Karanj cake and green manure for management of bacterial wilt in tomato cv. Pusa Ruby. The result revealed that different dose of Karanj cake and green manure has significant effect on reduction of *Ralstonia* population, plant survival and increased yield (Fig.18). Karanj cake @ 0.2kg /m<sup>2</sup> has significantly reduced *Ralstonia* population and increased the plant survival and yield (10.25 t/ha) against control (5.54 t/ha). Similar result was observed in green manure with *Sesbania* leaves in higher dose (10 kg/m<sup>2</sup>), after 90 days of application. The maximum yield was harvested with incorporation of green manure @ 10 kg/m<sup>2</sup> (7.76 t/ha) against control (4.46 t/ha).

*In vitro* experiment supplementation of *T. viride* or *T. harzianum* in *Sesbania* as green manure extract at 6.25 per cent to 12.5 per cent was most effective in reducing the growth of *R. solanacearum*. *T. viride* supplemented in fermented Neem cake or Karanj cake extract at 1 per cent have suppressed the growth of *Ralstonia solanacearum*. *T. harzianum* supplemented in fermented karanj cake extract 0.5 per cent was more effective than *T. viride* in reducing the growth of *R. solanacearum*.

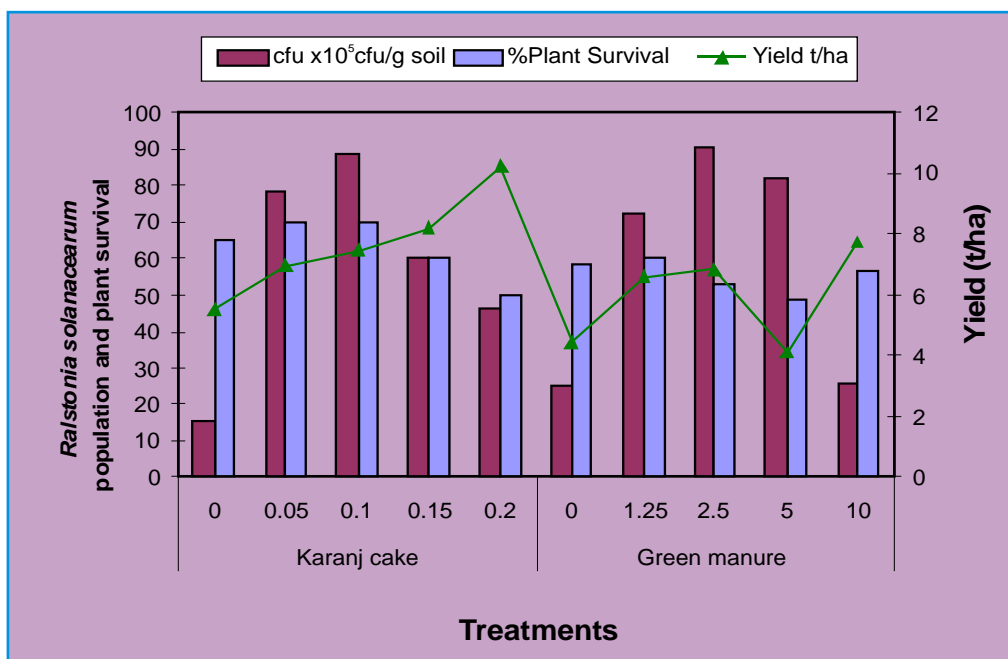


Fig. 18. Effect of different doses of karanj cake and green manure on *Ralstonia solanacearum*, plant survival and impact on yield of tomato (cv. Pusa Ruby)

### Identification of biovars of *Ralstonia solanacearum* race I in eastern India

Six isolates from tomato and brinjal (three each) collected from different villages viz Hatwal, Kuchu, Rajaulatu, Tutihara and Tundahali in Ranchi and Gumla revealed positive reaction to carbohydrates, which indicated the presence of biovar III of *Ralstonia solanacearum*.

### Integrated management of bacterial wilt in Solanaceous vegetables

The study on integrated management of bacterial wilt conducted *in vivo* with ten different organics and bioagent of two varieties (Swarna Lalima and Pusa Ruby) revealed significant variation due to varieties. Swarna Lalima was resistant under high pressure of inoculums in soil and recorded maximum plant survival whereas plants of Pusa Ruby being susceptible cultivar did not survive.

The minimum *Ralstonia solanacearum* population was found in Karanj cake @10 q/ha ( $T_6$ ) ( $40.85 \times 10^5$  cfu /g soil) followed by Liming @ 25 q/ha ( $T_8$ ) ( $47.21 \times 10^5$  cfu/g soil), PGPR @ 5 kg/ha ( $T_3$ ) ( $48.73 \times 10^5$  cfu/g soil), Spent mushroom compost @10 q/ha ( $T_7$ ) ( $50.4 \times 10^5$  cfu/g soil), Farm Yard Manure (FYM) @30 t/ha ( $T_1$ ) ( $52.58 \times 10^5$  cfu/g soil), Green Manuring with *Sesbania* ( $T_2$ ) ( $54.66 \times 10^5$  cfu/g soil) whereas in control it was  $60.52 \times 10^5$  cfu/g soil.

The best treatment was Karanj cake@10 q/ha for minimum *Ralstonia solanacearum* population, maximum plant survival and yield.

### Standardization of cultivation of button mushroom

Cultivation of button mushroom has been standardized by long method of composting. Maximum yield of 1.42 kg was recorded with minimum of 440 g per 5 kg compost and mean yield of 904.9 g from

---

---

64.33 numbers of fruiting bodies. Maximum yield frequency was found between 19-21 kg per quintal compost. Mean BE recorded 18.09 per cent.

### **AICRP(Vegetable crops)**

#### **(a) Varietal resistance Trials**

**Brinjal(IET) :** Out of seven entries, viz; BB54, Bholanath, VNR218, Singhnath, SM6-6, Arka Nidhi and PPL tested in sick plot, only BB54, SM6-6 and Arka Nidhi showed moderate resistance at 90 days against *Ralstonia* wilt.

**Brinjal(AVT II) :** Out of seven entries , viz; Swarna shyamali , SM 6-6 IIHR-7 ,IIHR-3 BB46-13, Arka Nidhi and PPL tested in sick plot, only Swarna Shyamali and IIHR -7 were resistant whereas Arka Nidhi was moderately resistant at 90 days against *Ralstonia* wilt. Rest of the entries were susceptible.

**Tomato (IET) :** Out of five entries, viz; BT 106, LE 626, LE 1-2, Megha Tomato -2, BT-1 and Pusa Ruby, all the entries except Pusa Ruby showed resistant reaction in sick plot at 90 days against *Ralstonia* wilt.

**Tomato (AVT II) :** Out of six entries, viz; H-62, H-63 BL 333-3 Megha tomato -1, BT-1 and Pusa Ruby, only four entries viz; H-62, BL 333-3 Megha tomato -1 and BT -1 showed resistant reaction in sick plot at 90 days against *Ralstonia* wilt .Whereas H-63 was moderately resistant.

**Tomato (AVT II Repeat) :** Out of five entries, viz; Palam Pride , Hawaii 7998, BT218 , BT-1 and Pusa Ruby tested, all the entries except Pusa Ruby showed resistant reaction against *Ralstonia* wilt at 90 days in sick plot .

#### **(b) Disease management Trials**

##### **Survey and surveillance of disease of important vegetable crops in the farmers' field**

Survey of incidence of disease in tomato and brinjal under farmers' field was conducted in 20 villages in eight blocks viz, Ormanjhi (9), Tamar (3), Silli (2), Khijri (2), Chkradharpur(1), Kuchai(1), Sonua(1) and Bandhgaon(1). Tomato cv Swarna Lalima and Swarna Naveen and brinjal cv Swarna Pratibha showed resistance reaction with plant mortality (2-20 per cent) and (2-15 per cent), respectively due to bacterial wilt. In Silli, bacterial wilt was 8-18 per cent in brinjal and 0-15 per cent in tomato in HARP varieties whereas high plant mortality 75-80 per cent was recorded in local cultivars. In Khijri block, the bacterial wilt was 9-20 per cent in HARP varieties and in local 85-90 per cent in brinjal and 5-15 per cent in tomato whereas in local it was 80-85 per cent. In Tamar block bacterial wilt in tomato was 4-10 per cent in Swarna Sampada only. In Chkradharpur block the incidence was 15-16 per cent in both brinjal and tomato. In Kuchai, Sonua and Bandhgaon the bacterial wilt was 12-20 per cent in brinjal whereas in Swarna Sampada it was only 5-10 per cent.

A new problem of collar rot caused by *Sclerotium rolfsii* was recorded in local/hybrids used by farmers. In above blocks the incidence of collar rot varied from 8-25 per cent in brinjal.

The early blight caused by *Alternaria solani* was found to be a major problem in farmers' field in local variety showing very high 85-90 per cent disease incidence whereas low incidence in Swarna Lalima (20-50 per cent), Swarna Naveen (0-25 per cent) and Swarna Sampada (5-25 per cent) was recorded.

## Integrated Management of soil borne diseases of vegetable crops with non-chemical methods

The experiment was conducted with 10 treatments viz; T<sub>1</sub>-Seedling grown in solarised bed, T<sub>2</sub>- Summer ploughing, T<sub>3</sub>- Locally available green manure (Cowpea), T<sub>4</sub>- Neem cake @10kg/ha, T<sub>5</sub>- Antagonist as seed, soil and seedling dip, T<sub>6</sub>-Green manuring +Antagonist, T<sub>7</sub>-Green manuring + Neem cake, T<sub>8</sub>- Green manuring +Neem cake +antagonist, T<sub>9</sub>-Locally adapted cultural practices (Karanj cake @10 q/ha) and T<sub>10</sub>-Control for integrated management of soil borne disease on French bean (Direct sown) and tomato (transplanted) in rainy season.

The results revealed that the direct sown crop suffers from soil borne pathogen *Sclerotium rolfsii* causing collar rot disease in French bean and bacterial wilt in tomato caused by *Ralstonia solanacearum*.

In French bean, the result revealed that there were no significant differences on incidence of collar rot as well as in yield. There was 104.6 per cent coefficient of variance in yield.

In tomato, the incidence of wilt was too high which may be due to heavy rain during the experiment, which showed non-significant variation in wilt. Similar trend was found in yield. However, the maximum yield (9.86 t/ha) was found in T<sub>3</sub> (Green manuring with cowpea) followed by 8.66 t/ha in T<sub>9</sub> (Karanj cake @ 10 q/ha) as against 3.03 t/ha in control.

## Epidemiology of most important diseases of commercially important crops of the locality

Twenty four sowing dates starting from Jan. 1<sup>st</sup> 2006 at 15 days interval were tested on tomato cv Pusa Ruby. No disease was observed on D1 to D17 (Jan.06 to April 06 sowing dates). In D8 (16.4.06) sown crop damping off incidence was seen. The early blight was seen in D19 (1.5.06) on 48<sup>th</sup> day and the progress was static whereas in D10 (15.5.06) sown crop disease appeared on 30<sup>th</sup> day in nursery and 50<sup>th</sup> day after transplanting. In the June 1, 2006 sown crops, the disease appeared in nursery stage and progressed steadily after transplanting. The disease appeared early in nursery stage and progress was rapid in rainy season (D14 - D15) crops. The progress was slow in winter-sown crop (D19 - D20). The appearance of early blight was caused by *Alternaria solani* disease and its progress was noted.

## Multiple correlation & regression study

The multiple regression study was done with six different periodic mean meteorological parameters with disease incidence (Table 8). The maximum R<sup>2</sup> was found in 1<sup>st</sup> Aug., 16<sup>th</sup> Aug., 30<sup>th</sup> Sept. & 15<sup>th</sup> Oct 2006.

Table 8: Multiple correlation & regression between disease progression and periodic mean meteorological parameters (2006-07) under different dates

Date of sowing	Multiple R	Regression equations
D9 (01.05.06)	0.981	Y= -131.96 + 1.33 X1 + 4.74 X2 - 5.21 X3 + 1.96 X4 - 0.02 X5 + 0.47 X6 (R <sup>2</sup> =0.964)
D10 (15.05.06)	0.995	Y= 31.02 + 7.16 X1 + 3.92 X2 - 9.56 X3 + 0.65 X4 - 0.01 X5 - 0.19 X6 (R <sup>2</sup> =0.991)
D11 (01.06.06)	0.935	Y= -81.57 + 17.34 X1 + 13.83 X2 - 22.86 X3 + 1.68 X4 - 0.006 X5 + 1.21 X6 (R <sup>2</sup> =0.875)
D14 (01.08.06)	0.852	Y= 550.50 + 6.07 X1 - 4.97 X2 + 4.67 X3 - 7.22 X4 + 0.18 X5 - 7.89 X6 (R <sup>2</sup> =0.726)
D15 (16.08.06)	0.951	Y= 59.49 - 3.91 X1 + 1.67 X2 + 1.55 X3 - 0.77 X4 + 0.01 X5 - 0.24 X6 (R <sup>2</sup> =0.904)
D18 (30.09.06)	0.999	Y= 42.004 - 4.99 X1 + 2.22 X2 + 0.9 X3 - 0.55 X4 + 0.70 X5 - 4.01 X6 (R <sup>2</sup> =0.999)
D19 (15.10.06)	0.943	Y= 98.70 + 0.356 X1 - 2.97 X2 - 0.34 X3 - 0.24 X4 - 0.11 X5 + 4.20 X6 (R <sup>2</sup> =0.889)

Y= a + b1X1 + b2X2 + b3X3 + b4X4 + b5X5 + b6X6, where Y=disease progression (per cent); a= intercept; b1, b2, b3, b4, b5, b6 are coefficients; X1=max temp.(°C), X2=min temp.(°C), X3=avg temp.(°C), X4=RH(per cent), X5=Total Rainfall(mm), X6=number of rainy day

---

---

## Effect of seed dressing chemicals, bio agents and insecticide on seed mycoflora, compatibility and seed germination.

The seed treated with fungicides viz; captan and carbendazim was superior to other fungicides but they were at par among themselves. These fungicides were compatible among themselves hence it can be recommended for seed dressing fungicides for control of externally seed borne pathogens either alone or in combination with the fungicides stated above in both tomato and brinjal as it gave good seed germination and root and shoot growth. The germination in microbes (*Trichoderma viride*) treated seeds were at par but root and shoot growth were reduced in both tomato and brinjal but it requires further confirmation. The chemical viz; Tri sodium phosphate resulted maximum germination in tomato but it was harmful in brinjal root and shoot growth.

### AICRP(Mushroom)

#### Strainal evaluation of milky mushroom

##### (*Calocybe indica*)

Out of four strains tested viz; CI-1, CI-3, CI-6 and CI-7 of *Calocybe indica* during summer months (April - May), yield in all strains were at par. The Yield varied from 940 g to 1106 in CI-7 and CI-3, respectively with mean of 993 g per kg dry straw. The mean biological efficiency (BE) was 99.3 per cent, which indicated that all strains can be cultivated successfully in summer.

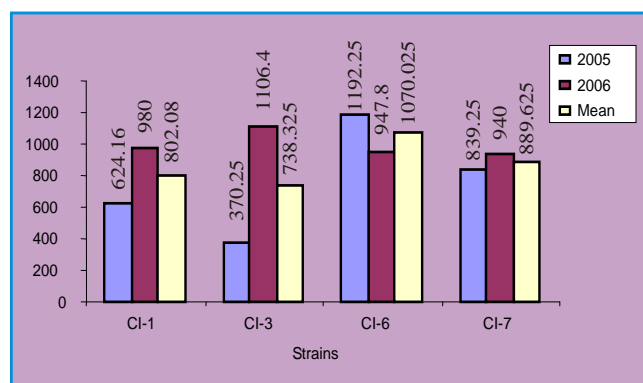


Fig. 19. Performance of strains of milky mushroom (*Calocybe indica*) during 2005 and 2006

#### Strainal evaluation of paddy straw mushroom (*Volvariella volvacea*)

Out of five strains of *Volvariella volvacea* viz; VV-1, VV-4, VV-6, VV-7 and OE 112 tested during April, May and September, three strains viz; VV-6, VV-7 and OE 112 were suitable and better than others which resulted in 11.3, 13.9 & 8.1 per cent BE, respectively during summer and monsoon seasons.

#### Cultivation of milky mushroom (*Calocybe indica*)

APK2 strain *Calocybe indica* was tested during summer months. The data revealed that April-May spawned bags resulted in 70.37 per cent and 16.81 per cent biological efficiency (BE), respectively. May spawned bags resulted in low yield. APK2 strain can be thus successfully cultivated in summer months.

#### Others

#### Collaborative Research Programme on maize (*Zea mays* L.) with VPKAS, Almora

(Sanjeev Kumar)

#### Trial 1. Agronomic evaluation of different maize germplasms and hybrid maize (Vivek-17)

VPKAS, Almora had supplied seeds of different maize germplasms including hybrid maize, Vivek-17 and other inputs to evaluate their performance in the eastern region. The trial was laid out at WALMI Farm of the complex and the varieties were tested under LEWA method of irrigation and surface method of irrigation. Results obtained from first year of experimentation revealed that variety

---

---



*A promising crop of Vivek-17*

Vivek-17 falls under early group which matures in 130-135 days as winter crop and can perform well under the climate of eastern region. However, the grain yield obtained with LEWA and Surface methods of irrigation were 2.96 and 2.56 t/ha respectively and was lower than the yield potential of the variety (4.5-5.0 t/ha). This might be due to its late sowing (25<sup>th</sup> Dec., 2005) faced with abrupt rise in temperature at grain formation stage and it resulted in forced maturity leading to lower yield (Table 9).

Table 9. Effect of irrigation methods on yield attributes and yield of maize

Irrigation methods	Plant height (cm)	Leaf no.	DM/ plant (g)	Cob/ plant	Kernel row/ plant	Grain wt.(g) (100)	Cob wt. (g)	Grain yield (t/ha)	Stone yield (t/ha)	Stover yield (t/ha)
LEWA	168.7	11.8	357.3	1.3	17.2	30.8	254.6	2.96	1.31	7.05
Surface method	165.2	11.5	315.6	1.2	17.2	28.7	246.7	2.56	1.36	6.53

Average value of all growth and yield parameters were found superior with LEWA irrigated crop than surface irrigated crop. This might happen due to the reason that LEWA irrigated crop has got frequent irrigations (8 no.) whereas, surface irrigated crop received only 5 irrigations and thus resulted in better vegetative and reproductive growth of plants as the plants had got opportunity to extract optimum soil-moisture and nutrients at each stage of growth or whenever required.

**Trial-2: Hybrid seed production of maize variety (Vivek-17) through CM 153 (female) x CM 212 (male) inbred in eastern Bihar**

The trial was laid out at WALMI Farm of the Complex (sown on 25 Dec., 2005) with an isolation distance of 400m to avoid pollination from the local pollens. Male line CM 212 and female line CM 153 were sown in the field in 1:2 ratio with a spacing of 60 X 20 cm. Variety Vivek-17 produced 1.0 t/ha seeds which was lower than its potential seed yield (1.6-2.0 t/ha). This might be due to the fact that delayed sowing of male and female lines resulted in unsynchronized tasseling and silking leading to poor pollination and fertilization among the female plants which ultimately resulted in poor seed setting in the cob.

