

WEATHER REPORT

In Sikkim, the maximum rainfall of 606.5 mm was received during Jul, 2011 where as minimum rainfall was recorded in Jan and Feb 2012. The maximum average temperature (27.36 °C) was observed in Jun, 2011 and the minimum (13.65°C) in Jan,2012.The maximum relative humidity of 90.64 % was observed during Jul, 2011 and the minimum of 82.67% in Mar, 2012.

Table 1 Mean monthly weather parameters from Apr'11 to Mar' 12

CROP SCIENCE

Months	Temperature		Relative Humidity		Bright Sunshine hours	Total Rainfall
	Max	Min	Max	Min		
Apr	26.08	13.80	83.8	41.76	3.67	14.2
May	27.07	17.29	86.32	53.96	4.25	10.45
Jun	27.36	19.60	88.56	60.36	3.29	21.29
Jul	26.97	20.08	90.64	71.29	0.92	24.98
Aug	26.88	19.88	90.45	66.80	2.26	16.67
Sep	26.01	18.49	90.4	62.66	2.02	11.27
Oct	25.87	15.65	90.38	50.93	5.01	1.49
Nov	19.01	15.14	88.56	52.20	1.77	52.20
Dec	16.92	8.70	87.12	50.35	0.30	4.3
Jan	13.65	6.12	87.19	49.61	0.93	0.64
Feb	25.93	8.78	86.86	42.93	3.07	0.99
Mar	22.76	11.51	82.67	39.90	2.80	1.45

RICE

Performance of released upland varieties under midhills

Six high yielding upland rice varieties *viz.* Bhalum1, Bhalum2, Bhalum-3, Bhalum 4, RCPL-412 and RCPL-413 were tested under midhill conditions. The entries were tested in RBD design with 4 replications having 3 rows in each replication. Five plants were randomly selected for data recording in each entry. Among the entries Bhalum-2 and Bhalum-1 were earliest in maturity (127 and 128 days respectively). Highest grain yield per plant was recorded in Bhalum-3 (29.26 g) followed by RCPL-412 (28.46 g). Data is shown in Table 2

Table 2 Yield and its related traits in upland paddy varieties

Entries	No. of producti ve tillers/pl ant	Panicle s /m ²	Panicle length (cm)	Grain s /panicle	Days to 50% flowering	Days to 75% maturity	100 grains weight(g)	Yield per plant(g)
Bhalum-1	5.55	194.66	22.50	136.22	86	128	2.40	25.73
Bhalum-2	6.55	187.33	21.82	150.77	85.33	127.66	2.60	28.06
Bhalum-3	6	197.33	20.53	136.44	91	136.33	2.47	29.26
Bhalum-4	6.55	188	19.24	125.77	89.66	135.66	2.36	21.88
RCPL-412	6.22	194.66	19.53	165.44	96.33	135.66	2.28	28.46
RCPL-413	5.22	185.33	20.73	188	95	135.33	2.23	21.82
SEM	0.50	16.86	0.71	14.03	0.38	0.32	0.16	1.89
CD (<i>P</i> =0.05)	1.60	53.13	2.25	44.21	1.22	1.03	0.52	5.96

RCRT Upland

Seventeen upland paddy lines (RCPL1-114, RCPL1-128, RCPL 1-129, RCPL 1-130, RCPL 1-80, RCPL1-82, RCPL1-90, RCPL1-93, RCPL1-103, RCPL1-111, IR60080-46A , Bhalum-1, Bhalum-2, Bhalum-3, Bhalum-4, RCPL1-412 and RCPL1-413) evaluated under midhills of Sikkim. The entries were grown in RBD design with row of row and plant to plant distance of 25cm and 15 cm respectively. The data was recorded randomly on five plants. Among the entries Bhalum-2 was earliest in maturity (127 days) followed by Bhalum-1 (128 days). Highest grain yield per plant recorded in Bhalum-3 (29.26 g) followed by RCPL-412(28.46 g). The characters of different lines have been shown in Table 6.

RCRT Lowland

Thirty nine entries of lowland paddy have been evaluated for assessing their suitability for cultivation under Sikkim lowland conditions. Out of it, 3 entries were rejected due to poor performance. The entries were grown in RBD design having 3 rows of each entry in 3 replications. Days to 50% flowering recorded lowest in entries RCPL1-470 (51 days), RCPL1-

466, RCPL1-126, RCPL1-474 and RCPL1-475(55 days each). Yield per plant recorded highest in RCPL1-473 (76.80 g) followed by RCPL1-417 (74.55 g).

DISEASES

Organic management of blast and sheath blight

The sheath blight pathogen *Rhizoctonia solani* was isolated from the diseased samples of rice plants. The pathogen was purified using hyphal tip method and cultured on PDA media. The pathogenecity was tested. The pathogen produced large oval spots on the leaf sheaths and irregular spots on leaf blades (Fig 1).The pathogen *R. solani* produced sclerotia and white colour colony which later became brown. The mycelium is Pale to dark brown, relatively large diameter with branching near the distal septum of the hyphal cells, often nearly at right angles in older hyphae . Different *Trichoderma* isolates collected from different districts of the Sikkim was studied for their antagonistic effect against *R. solani* using dual culture technique. Among the various isolates tested the isolate T2 collected from Panthang was very effective in inhibiting the growth of sheath blight pathogen with 78.88 per cent inhibition over control followed by T5(75.18%), T3(73.70%), T9(73.33%), T28(71.10%) and T25(70.73%) collected from Today busty, Nandugaon, ICAR, Tadong respectively. The least per cent inhibition over control (42.22%) was observed in T33 isolate collected from ICAR farm Tadong.



Fig 1 sheath blight affected rice plant

MAIZE

Population improvement in early maturing and high yielding composites of maize (*Zea mays* L.)

Yellow seeded

Superior cobs from superior single plants have been selected in yellow seeded population (coded C-2). These composite seeds of selected plants have been grown during March, 2012.

White seeded

Superior cobs from superior single plants have been selected from white seeded population C-11 and have been grown during March, 2012.

BUCKWHEAT

Performance of local buckwheat cultivars under different levels of vermicompost

Buckwheat is the most important life support, multipurpose and nutritious crop of the tribes living in Sikkim. It is the only crop grown up to 4500 m elevation. Farmers of Sikkim could not able to get the reasonable yields, because they grown the crop with minimum or very less nutrients inputs. The aim of the study was to quantify the optimum doses of organic inputs (vermicompost) for profitable cultivation of local buckwheat cultivars. The experiment was conducted during *rabi* season (22 Nov sowing). The experiment was laid out in FRBD, assigning local cultivar “*Mithe and Tithe*” (Fig 2 a & b) as a factor A and levels of vermicompost (Control, Vermicompost @ 1000 kg/ha, Vermicompost @ 1500 kg/ha and Vermicompost @ 2500 kg/ha) as a factor B. All the treatments replicated thrice. Local cultivar “*Tithe*” was more responsive to vermicompost application compare to “*Mithe*”. *Tithe* cultivar gave approximately 20% higher grain yield compare to *Mithe* at same level of vermicompost. However, highest grain yield of both the local cultivars was recorded with the application of vermicompost @ 2500 kg/ha.



Fig 2 a *Tithe* cultivar of buckwheat, 85 DAS and
b. *Mithe* cultivar of buckwheat, 85 DAS

OILSEEDS

TORIA

Effect of mulching and vermicompost on growth and productivity of toria

Toria is one of the most important oil seed crops of Sikkim. The crop can be raised well both under rainfed and irrigated conditions. Being more responsive to nutrients inputs, it gives better

returns under irrigated conditions. Post rainy season of Sikkim hardly enjoy any rainfall and crop suffer due to water scarcity in latter stages. And also farmers grow the toria crop with minimum or no nutrients inputs and ultimately get low yield. A field experiment was conducted in post rainy season (Nov – Jan) in 2011-12 at agronomy research farm of ICAR (RC) NEH Region of Sikkim centre, Tadong, Gangtok. The objective of study was to find out the effect of mulching and vermicompost on growth, productivity and economics of toria var. M-27. The treatments comprising of four levels of mulching (Control, Tree leaf (*Chilawney* + *Utis*) mulch @ 5 t/ha, Maize stover mulch @ 5t/ha and Paddy straw mulch @ 5 t/ha) as main plots treatments and three levels of vermicompost (Control, vermicompost @ 1000 kg/ha and Vermicompost @ 1500 kg/ha) as sub-plots and replicated four times in split plot design. Combination of tree leaf (*Chilawney*+*Utis*) mulch @ 5 t/ha and vermicompost @ 1500 kg/ha was recorded the maximum grain yield (1.29 t/ha) of toria.

RAPSEED

Genetic advancement of elite rapeseed material suitable for cultivation under Sikkim conditions

Nineteen single plant selections and one bulk selection have been done from yellow sarson population (SSY-1) developed at the centre. The selection has been done on the basis of days to maturity, siliqua number and seed yield per plant (g). These have been tested under rainfed conditions. Toria population *SKMT-2*; a selection made from the segregating population of *SCRT 1-1-1* was sown in isolation for its pure seed production. The population matures in about 100 days and yields approximately 12q/ha.

SOYBEAN

Research Complex Regional Trial

Five entries of Soybean developed at ICAR, Barapani have been tested during *kharif*, 2011. The entries were grown in a plot size of 2.25m² with 3 replications in RBD design.. The data was recorded randomly on five plants. Entry RCS1-10 recorded highest yield (807.00 g) followed by Bragg (741.66 g). RCS1-10 was earliest in maturity (105 days). The data is shown in Table 3.

Table 3 Performance of Soybean entries

Entres	Plant height (cm)	No. of primary branches	No. of pods /plant	No. of clusters	Days to 50% flowering	Days to maturity	Yield per plot(g)
Bragg	66.66	9.46	87.13	31.88	48	106	741.66
RCS1-1	52.33	9.33	62.60	24.88	56.66	108	460.66
RCS1-9	61.46	9.13	64.53	23.22	48	108	690.66
RCS1-10	76.80	10.66	72.60	27.33	46	105.66	807.00
JS-93-05	38.20	7.00	38.66	13.88	40	111.66	328.33
S.E	2.43	0.65	4.33	1.66	0.39	0.22	58.58
C.D 5%	7.93	2.12	14.13	5.42	1.28	0.72	191.05

MUSTARD

INSECT PEST

Seasonal abundance of mustard aphid and saw fly with relation to abiotic factors and their management

Rapeseed - mustard is a major oil seed crop in Sikkim. Mustard aphid and saw fly (Figs 3- 4) are major pests leading to poor yield of this crop. Therefore an experiment was conducted to study the seasonal abundance of mustard aphid and saw fly with relation to abiotic factors (Tables 4 -5). The total area was divided into four plots and from each plot 10 plants were selected randomly to take observation of population of mustard aphid and saw fly at weekly interval. The meteorological data were also collected periodically. From the study it was observed that the aphids appeared first on 49th standard week and the population was found maximum on 2nd standard week (49.07 aphids/10 cm central shoot). The saw fly population appeared on 45th standard week and attained maximum on 47th standard week (1.57 larvae/plant). The correlation study reveals that the population of aphid is significantly influenced negatively by the maximum temperature ($r = - 0.67$) and minimum temperature ($r = - 0.68$). The population increase with the decrease of temperatures whereas the population of saw fly influenced positively i.e., the population increase with the increase of maximum temperature ($r = + 0.62$) and minimum temperature ($r = + 0.64$). *Coccinella septempunctata*, *Menochilus sexmaculata* and Syrphid fly were found some potential natural enemies for reduction of aphid population.



Fig 3 Mustard aphid infestation



Fig 4 Mustard sawfly infestation

Table 4 Effect of abiotic factors on population of mustard aphid and saw fly

Date of observation	Standard week	No. of aphids/10 cm central shoot	Date of observation	Standard week	No. of saw fly per plant
5.12.2012	49	8.47	07.11.2012	45	0.32
12.12.2012	50	12.67	14.11.2012	46	0.75
19.12.2012	51	18.2	21.11.2012	47	1.57
26.12.2012	52	25.22	28.11.2012	48	1.37
02.01.2012	01	37.35	05.12.2012	49	1.10
09.01.2012	02	49.07	12.12.2012	50	0.72
16.01.2012	03	41.65	19.12.2012	51	0.30
23.01.2012	04	28.07	26.12.2012	52	0.47
30.01.2012	05	11.55	02.01.2012	01	0.54
06.02.2012	06	6.0	09.01.2012	02	0.10

Table 5 Correlation between population of mustard aphid and saw fly and abiotic factors

Population/abiotic factors	Temperature 0C		Humidity (%)		Rainfall (mm)	BSS (Hrs)
	Max.	Min.	Max.	Min.		
Mustard aphid	-0.67*	-0.68*	-0.19	-0.11	+0.30	+0.02
Mustard saw fly	+0.62*	+0.64*	+0.10	-0.12	+0.18	+0.52

* Significant at (0.05)

Study of the foraging behavior of different insect pollinators in mustard

Mustard is a cross pollinated crop and the pollinators play pivotal role for increasing production of this crop. Honeybees visit mustard flowers for collection of both pollen and nectar, which in turn results into florets get cross pollinated. Besides honeybee there are so many insect visitors which visit during flowering time and accomplish pollination. An experiment was conducted to study the foraging behavior of different insect pollinators in mustard. Two sq.m plot of mustard crop was taken and the number of pollinators visit to the plot in 10 minutes was recorded in

different periods of the day. Observations were taken for 6 days continuously. Eleven insect pollinators (Table 6) were recorded. Some of them were nectars feeder and some pollen robbers. Among the visitors, *E. himalayensis*, *Apis cerana indica*, *Eristalis tenax*, *E. sp* and *Bombus breviceps* visit more. The visit of insect pollinators was influenced positively by the SSH. The population of pollinators was less in cloudy and rainy days. The maximum population of all pollinators was observed during 10 AM to 11 AM (*A. cerana indica*) followed by 11AM to 12 Noon. The maximum yield was recorded in the honey bee, *Apis cerana indica* pollinated crop followed by *E. tenax* and *E. himalayensis*.

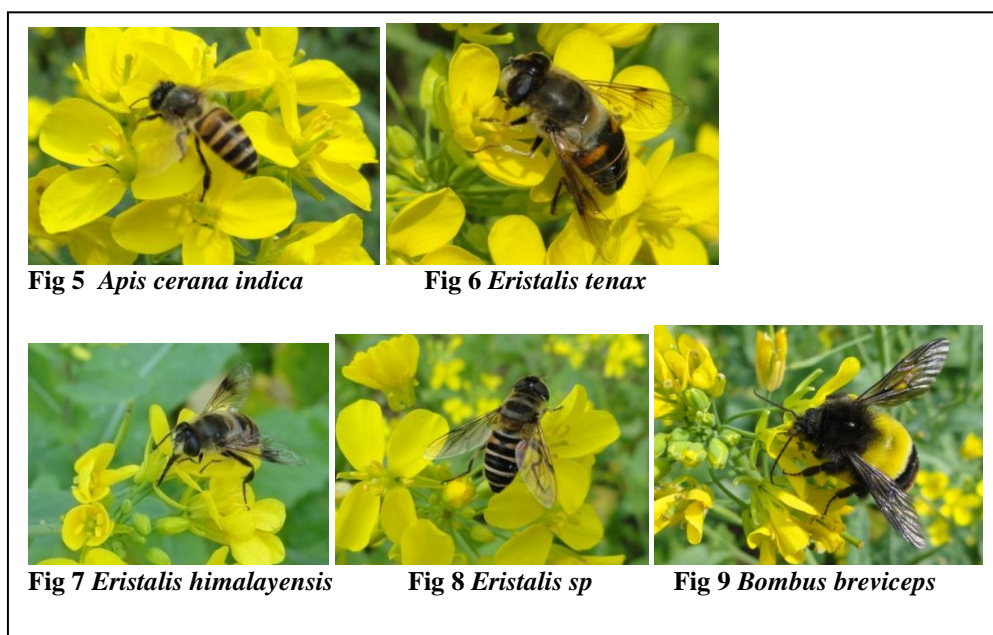


Table 6 List of insect pollinators observed in mustard

Pollinators	Order	Remark
<i>Apis cerana indica</i>	Hymenopter : Apidae	Nectare and pollen
<i>Eristalis tenax</i>	Diptera :Syrphidae	Nectare
<i>Eristalis himalayensis</i>	Diptera :Syrphidae	Nectare
<i>Eristalis sp</i>	Diptera :Syrphidae	Nectare
<i>Bombus breviceps</i>	Hymenoptera : Apidae	Nectare and pollen
<i>Habropoda sp</i>	Hymenoptera: Anthophoridae	Nectare and pollen
<i>Danaus chrysippus</i>	Lepidoptera : Nymphalidae	Nectare
Syrphid fly	Diptera :Syrphidae	Nectare
Blue housefly (<i>Lucilia sp</i>)	Diptera : Calliphoridae	Nectare
Cabbage butter fly	Lepidoptera :Pieridae	Nectare
Rice skipper	Lepidoptera : Hesperidae	Nectare

DISEASES

Management of white rust in mustard under organic conditions

White rust caused by *Albugo candida* is an important pathogen inflicting severe losses to the mustard crop. The pathogen produces white rusty spots on the underside of the leaves. The pathogen also causes malformation of inflorescence. The field experiment was conducted using Various treatments such as *Trichoderma viridae* (Trichostar), onion 10%, garlic 10%, chiloley 10%gingher 10%, turmeric 10%, lantana 10% cow urine 10%, neem oil 10% and metalaxyl against white rust incidence under organic condtions with control. Among the treatments Trichoderma seed, soil treatment and spray @ 0.2% was very effective in reducing the disease with PDI of 21.55 compare to control (52.91PDI, which was on par with Metalaxyl @ 0.2% (PDI 16.13).The number of plants bearing stag head also very less(1) in metalaxyl treated plot followed by Trichoderma(3.66) and neem oil (3.66) treatments. The incidence was highest in control followed by onion (PDI 52.91). The highest number of stag head infected plants were observed in control (14.66) followed by onion (12.33), garlic (11.66), lantana (11) and cow urine (11) treated plots (Table 7).

Table 7 Effect of various treatments on white rust incidence on mustard

Treatment	Percent disease incidence	No of stag head
Cow urine 10%	38.09	11.00
Artemisia 10%	42.46	13.00
Neem oil 3%	29.41	3.66
Lantana 10%	42.91	11.00
Chiloney 10%	39.44	9.66
Garlic 10%	36.94	11.66
Onion 10%	52.91	12.33
Turmeric 10%	38.70	8.00
Ginger 10%	31.64	5.00
Trichoderma seed and soil treatment, spray	21.55	3.66
Metalaxyl 0.2%	16.13	1.00
Control	44.57	14.66
CV (%)	7.62	29.00
CD ($P = 0.05$)	4.67	3.97

PULSES

URD BEAN

Pahelo Dal-3(PD-3) an urdbean variety

A new variety of Pahelo Dal 3 (SKMPD 3) (Table 8) developed at the centre has been released by the Sikkim Seed Committee on 17-01-2012. Pahelo Dal (Green seeded urdbean) is a landrace of Sikkim. Unlike black seeded urd pulse it is greenish in colour with bold seeds. The new variety has been developed by pureline selection from the local material. It is suitable for organic farming system in which it yields an average of 9.5q/ha.

Table 8 Characteristics of Pahelo Dal 3

Parentage	Developed from Local Pahelo Dal collections of Sikkim
Breeding method	Pureline selection
Specific area of adoption	Midhills of Sikkim
Distinguishable characters	Determinate growth, Synchronous habit, seed shape globose shiny, plant height 55cms, semierect growth habit, stem pubesc present, leaflet ovate, foliage colour dark green, pod colour green.
Maturity	101 days(Medium maturity)
Average yield	950Kg/ha

RAJMESH

Evaluation of germplasm

Thirty five bush type Rajmash entries were evaluated during pre-Rabi 2011. The entries were grown in a plot size of 1.80 m² with three replications in RBD pattern with three rows of each entry per replication. The data was recorded randomly on five plants from each entry in each replication. Out of 35 entries, 6 entries showed poor germination and therefore rejected for data collection. Among the entries SKR-21, Naogaon Rajmash and SKR-21 were earliest in maturity (112, 113 and 119 days respectively). Yield per plant was highest for entries IPR 9-6-4 (12.10 g), Naogaon Rajmash-3(11.23 g) and HUR-07-48 (10.32 g).

FRUITS

SIKKIM MANDARIN

INSECT PEST

Bio rational management of insect

An experiment was conducted to evaluate the bio rational management strategies for management of insect pests in Sikkim Mandarin. Two orchards consisting of 20 trees were

selected for the study. In one plot the practices like a) cleaning of orchard, b) smearing of Bordeaux paste at the base of the trunk up to 1 m height, c) frequent monitoring d) two spraying of Servo (Agrospray) @ 7 ml/L in the month of May for control of aphids and leaf miner and one spraying of *Bacillus thuringiensis* @ 2g/L when infestation of lemon butterfly starts. e) cleaning of trunk borer and bark eating caterpillar infested plants and insertion of iron wire to kill the larvae and insertion of cotton soaked in petrol or kerosene to the holes and plastered with soil and cow dung mixture. f) Installation of para pheromone trap etc were followed and in another plot cleaning of orchard was done as done by the farmers. In the first plot the infestation of insect pests was less (lemon butterfly 2 larvae per 50 shoots, 6.0 % leaf miner infested shoots, 4.0 % aphid infested shoots, 10 % trunk borer and 10% bark eating caterpillar and 8 % fruit fly infestation in comparison to other plot(lemon butter fly 11.0 larvae/50 shoots, 30.0% leaf miner infested shoots, 18.00 % aphid infested shoots, 60 % trunk borer infestation, 40% bark eating caterpillar infestation and 30% fruit fly infested fruits) and fruit yield was more (422.8 fruits/plant) in comparison to second plot (238.4 fruits/plant) where the practice was followed as followed by the farmers.

VEGETABLES

CHOW-CHOW

Genetic diversity study using morphological and RAPD markers

Sixteen chow-chow germplasm of Sikkim were analyzed for genetic diversity using some morphological traits (both quantitative and qualitative) and RAPD markers. Considerable diversity was found among the accessions for all the 15 traits studied. Highest fruit weight exhibited by S8 (461g) followed by S9 (416g) and S1 (399.09g). Highest dry matter content was found in S5. Highest ascorbic acid content was found in S2, S3, S10 and S11. Out of the 30 primers tested 12 were found to be polymorphic for all the accessions generating a total of 25 bands (2 bands per primer). The UPGMA dendrogram obtained from the cluster analysis using Jaccard's similarity coefficient divided the accessions in to four clusters. In the present study, in most cases, chow-chow accessions within the same cluster did not have similar morphological characteristics. Several primers were identified as good markers in the study. Of the various primers tested the primer 168(5'CTAGATGTGC3') and 188 (5'GCTGGACATC3') showed single band size of 5000 bp and 7000bp for the samples S6 and S1, respectively, so these amplified products can be used to differentiate the samples S6 and S1. In brief, RAPD markers

are useful to study the genetic relationships and the specific marker can be used as a diagnostic marker for chow-chow cultivars.



Fig 10 Variability in local chow-chow genotypes of Sikkim (S1-S16)

SPICES

GINGER

Heavy metal analysis in ginger (*Zingiber officinale*) rhizomes of Northeastern India

Heavy metal analysis was done on 22 rhizomes samples collected from different locations of Northeastern India. The samples were analyzed for concentration of volatile (As and Hg) and non-volatile (Pb and Cd) toxic heavy metals using Atomic Absorption Spectroscopy. Lead (Pb) and Cadmium (Cd) were detected in all the samples while one sample (Assam 2) showed detectable concentration of Arsenic (As). Samples from the state of Manipur showed highest mean concentration of Pb (0.96 µg/g). Highest concentration of Cd was found in sample Nagaland 3 (0.06 µg/g). All the heavy metals concentration was well below the permissible limits laid down by regulatory authorities (FDA). Among the four toxic metals analyzed in rhizomes collected from North Eastern India, Pb contributed the most (>85%) of all the metals.

DISEASES

Network project on management of soft rot of ginger

Survey and surveillance was conducted during 2012 in different districts of the state viz., Assam Lingzey, Linkey, Thekabong, Changeysanti and Panthang of East Sikkim, Dzongu, Heeygyathang, Kabi and Pachey of North Sikkim and Namchi, Nanduguan, Temi daragoan, Denchung, Aifartor of South Sikkim and Ravangla and Soreng of West Sikkim to study the soft rot to study the disease incidence. Disease diagnosis showed the prevalence of soft rot and also bacterial wilt, Fusarium dry rot in the field surveyed. The highest incidence of rhizome rot was observed in East district with 38.91% whereas lowest incidence of disease was observed in north district (15.25%). It is also observed that the incidence was very less or nil in the field where crop rotation is followed and disease free rhizome is used. Soil from different ginger growing areas was also collected and trichoderma was isolated from the rhizosphere soil. In total 34 Trichoderma spp were isolated from the rhizosphere soil and being maintained.

Plant extracts like garlic, onion, Artemisia, chiloney, Ephatorium at 10% concentration were tested against pythium spp by poisoned against Pythium spp food technique in vitro. It was found that garlic at 10% and Chiloney at 10% were most effective (Fig:2) in controlling the growth of the soft rot pathogen with 58.88 and 53.70 Percent inhibition over control (0%) . The growth of the colony was dense in all culture plates amended with different plant extracts except

the one with chiloney where the growth was sparse. The pathogen covered the culture plates within 4 days of inoculation whereas in case of the plates amended with garlic and chiloney it took more than 6 and 15 days respectively.

Under field conditions, various treatments were evaluated for germination of ginger rhizome. Among the treatments Trichoderma + Hot water treatment at 47°C for 30 minutes, Garlic + Hot water treatment at 47°C for 30 minutes and Neem cake + Hot water treatment at 47°C for 30 minutes showed comparatively better germination in comparison to other treatments. Eight different treatments were evaluated against soft rot of ginger during 2011. The per cent of disease incidence was recorded periodically. Among the treatments evaluated, the Trichoderma + hot water treatment was effective for controlling soft rot incidence followed by Neem cake+ Hot water treatment. In Sikkim there are three varieties of indigenous cultivars such as Gorubathaney, Bhaisae, Majhauley are commonly cultivated. These three varieties are screened for soft rot in ICAR Research farm (Tadong), Gangtok. Among these varieties all the varieties are showed susceptibility with more than 60% incidence of soft rot.

CARDAMOM

DISEASES

Molecular Characterization and Bio-intensive Management of *Collectotrichum gloeosporioides* the incitant of Leaf blight in large cardamom

The in vitro antagonistic effect of various Trichoderma isolates collected from various places in Sikkim was studied against *Collectotrichum gloeosporioides*. The maximum inhibition Percent was noticed for the Trichoderma isolate T37 collected from ICAR farm at Tadong Gangtok with 74.35 per cent inhibition over control which was at par with T2(69.20%) and T27(66.65%) collected from Temi Daragaon and ICAR farm respectively. Following this other treatments like T21(Pachey) and T36(Nandugoan) also showed maximum inhibition of 65.24 % and 65.24% respectively. The minimum inhibition per cent of 18.45 was noticed for the isolate T18 from Pachey.

ANIMAL HEALTH

Prevalence of gastrointestinal helminth of goat, cattle and yaks of Sikkim

Epidemiological studies on gastrointestinal helminthes of goat, cattle and yaks were carried out in four agroclimatic zones in all the seasons of Sikkim among animals maintained at organized

and unorganized farms of Government/Private/ICAR Institute and also from animals maintained by livestock owners in different villages.

A total of 6824 animals were examined during the study period. An overall prevalence of 40.84% helminthic infestation was observed. Among the different animals examined, the occurrence of GI helminthic infestation was found to be higher in goats (63.08 %) than that of cattle (30.58 %) and yaks (17.72 %). The mixed infestation of trematode, cestode and nematodes with coccidian oocysts were found higher in goats than in other animals. The mean epg value was also higher in goats as compared to cattle and yaks. The prevalence of GI-helminthes was higher in subtropical and high humid zone (46.63 %) followed by Temperate and humid area (41.21 %) as compared to Subalpine low humid zone (32.23 %) and alpine dry area (16.55 %). The helminthic infestation was higher during the month of August to October with the highest peak in October (78.62 %) in goats and in May in cattle (40.72 %) as compared to yaks. This may be due to high rainfall and favourable temperature (26-27⁰ C), which is congenial for the development of parasitic infestation . Monthly evaluation of the data revealed that strongyles especially *Haemonchus* was the most prevalent parasite in all three animals throughout the year in Sikkim.

The intensity of infestation in terms of eggs per gram of faeces (epg) ranged from 100-4200 in goats, 100-700 in cattle and 100-300 in yaks. The maximum epg in goats was recorded in the month of October (mean epg value 3000.00) with epg ranges from 1700-4200. In cattle, the intensity was maximum in the month of July to September (100-700), whereas in yaks, mean epg of 50.502 was found in the month of Nov. This indicated that during North- East monsoon maximum animals used to get infestation with various GI-helminthes in the pasture.

Study on larvae

Pooled infested faecal samples of goat, cattle and yaks from various places were cultured for larval composition. Infested cultured larvae were separated using Bayermanns apparatus. The larvae were identified as *Haemonchus* spp., *Bunostomum*, *Nematodirus* and *Oesophagostomum*, spp., in all the zones in Sikkim. Maximum contamination of pasture with third stage larvae was recorded in the month of August to November . *Haemonchus contortus* and *Oesophagostomum* was the predominant species followed by *Bunostomum*, *Nematodirus* and *Trichostrongylus* sp.

Incidence of gastrointestinal parasites in different organized farms of Sikkim

The highest prevalence of parasitic infestation was seen in Govt. Goat Farm at Mangalbarey, West Sikkim (78.79 %) with epg ranges from 900-3900 followed by private Goat farm at Lyngepoyang, South Sikkim (67.39%) , ICAR Goat Farm, Tadong, East Sikkim (53.22%) and Govt. Bull Breeding Farm, Jorethang, South Sikkim (23.40%). The prevalence at private yak farm, Gnathang, East Sikkim was 15.77%.

Prevalence of gastrointestinal helminthes in goats as determined by necropsy examination

The 72 GI-tract of goats examined, helminthic infestation with an overall prevalence of 62.50% were found to harbour . Among the various endoparasites, nematodes (61.11 %) were found higher followed by trematodes (33.33%) and cestodes (30.56 %). Among nematodes, *Haemonchus* spp. was predominant (61.11%) followed by *Oesophagostomum* (45.83%), *Bunostomum* spp. (29.17%), *Nematodirus* spp. (11.11 %), *Trichuris* spp. (9.72%) and *Trochostrongylus* spp. (6.94%). Average worm burden (200.12 – 278.73) was higher in the month of July -November followed by the month of June-July (150.55-200.12).

Season -wise prevalence of gastrointestinal helminthes in goat, cattle and yaks in Sikkim

Out of the four seasons, significantly higher helminthic infestation was observed during summer (Jun-Aug) in goats (71.41%) and cattle (35.42%) and yaks in autumn (19.19 %). Comparatively low infestation was observed during winter (50.96% in goats) and 22.77% in cattle and 13.46% in yaks . Mixed infestation of trematode, cestode, nematode and coccidian oocysts were observed during all the seasons in Sikkim. The mean epg value was higher in monsoon and post-monsoon season in goats and cattle than spring and winter. The highest mean epg values of yaks were seen in autumn (50.502) as compared to spring and winter.

Correlation of meteorological data with epg count

Meteorological parameter such as mean minimum and maximum atmospheric temperature, mean relative humidity and total rainfall were collected from the Meteorological station, Tadong, Gangtok for interpretation of the Bioclimatograph. Climatic factors were correlated with epg count by multiple regressions.

Bioclimatograph of *Haemonchus* and *Trichostrongylus* spp.

To see the effects of temperature, rainfall and relative humidity, bioclimatographs (Table 9) were prepared in which total rainfall (TRF) were plotted against the maximum temperature (Tmax) for *Haemonchus contortus* and average RH was plotted against Tmin (for *Trichostrongylus* spp. and minimum temperature for *Nematodirus filicollis*) for each month and the resultant points were joined by a closed curve. On these graphs, lines indicating the limits of climatic conditions most suitable for development, survival and dissemination of pre-infective stages of GIN were superimposed.

Based on published information the limits of suitable climatic conditions were taken as total monthly RF to the tune of 50 mm or more with average monthly Tmax ranging from 18 to 37 °C for *H. contortus* and same rainfall with temperature ranging from 6 to 20 °C for *Trichostrongylus*. The RH considered for optimum development of parasites was >50%.

Table 9 Comparative prediction and testing of different bioclimatograph for GIN in goats in subtropical high humid zone of Sikkim

Climatological factor	Nematodes	Favourable period as per bioclimatograph	Months of high prevalence (Observed)	Months of high intensity (Observed)
(Tmax vs TRF)	<i>H. contortus</i>	Apr to Oct	May to Nov	Jun to Nov
(Tmax vs RH)	-do-	Feb to Oct	May, Jun , Jul and Aug	Jul to Oct
(Tmin vs TRF)	-do-	Apr , May, Jun, Sep to Oct	Aug, Oct	Aug to Nov
(Tmin vs RH)	-do-	Feb to Jun	Apr , Jun	May to Jun
(Tmin vs RH)	<i>Trichostrongylus</i>	Feb, Mar, Apr, May, Oct, Nov	Mar, Apr, Oct	Mar to Apr
(Tmax vs RH)	-do-	Dec, Jan	Dec	Dec
(Tmin vs TRF)	-do-	Apr , May, Jun, Oct	Apr	Apr to May
(Tmax vs TRF)	-do-	Nil	Nil	Nil

Economic impact of gastrointestinal parasites in livestock of Sikkim

Gastrointestinal parasites are known to cause significant economic losses due to reduced body weight, retarded growth, low milk yield and reduced reproductive efficiency in the Livestock industry of India. In a preliminary study on milch cattle, in the village known as Melli-Meji gaon (1,600ft.MSL) located in the East District, Sikkim, a net profit of Rs. 1930/- over a period of one month was recorded in the group which were naturally infested and treated with anthelmintics. The infected and untreated group showed net loss of Rs. 2240/- in terms of earnings from the milk produced over a period of 1 month.

Molecular characterization of *salmonella* isolated from foods of animal origin

During the year 250 meat samples including of Chicken, Chevon, Pork, and Beef were screened from the retail shops for the presence of *Salmonella* spp. Of the 250 samples comprising Chicken (85), Chevon (75), Pork (50), and Beef (40), screened for the presence of *Salmonella* spp., a total of 25 samples turned out to be positive for *Salmonella* spp, resulting in an overall incidence of 10%. *Salmonella* were recovered from 14.11% of Chicken samples, 5.33 % of Chevon, 12% of Pork and 7.5% of beef samples. All the isolates were confirmed as *Salmonella* by biochemical characterization. Antibiotic sensitivity testing of isolates showed significant resistance among the isolates. Most effective antibiotics were Colistin, Gentamicin and Ciprofloxacin. Serotyping of the isolates was done. *S. Typhimurium* was the most predominant serovar isolated from all types of meat screened.

Evaluation of feeds and fodders of Sikkim in terms of their anti - methanogenic activities

Volume of methane gas liberated during in-vitro fermentation was estimated at the end of 96 h of incubation period from 72 different grasses commonly fed to livestock like tree fodders, shrubs, creepers, plant species of medicinal or aesthetic use, vegetative parts of spices crops of the region, aromatic plants, tree fruits having medicinal values etc. was analyzed statistically.

Results showed a wide variability in gas production among samples at different time intervals. Inoculums pH ranged from 8.21 to 8.51 differ significant ($P < 0.01$) however, apparently could not affect the fermentation pattern. Total gas production in various samples differ significantly ($P < 0.05$) after 12, 24 and 96 h of incubation period. The chemical composition of fodder

samples could not be correlated with volume of total gas and methane. However, an increasing trend of methane production in fodders containing low ether extract content could be noted. During study 92.5% samples have a non significant methane production value.

Nutritional evaluation of NB-21 hybrid Napier grass

It can be concluded from the present study that NB-21 variety of hybrid Napier green fodder (21.12% DM) was evaluated in a metabolism experiment in goats (BW 11.20 ± 0.28 kg). The fodder contained 11.62, 2.45, 64.67, 41.51, 4.49, 0.49, and 0.17%, respectively, of CP, EE, NDF, ADF, ADL, Ca, and P. The dry matter (DM) intake of goats was 270.50 ± 7.17 g/day, which came to 2.42 as % of body weight (BW) and 45 g/kg metabolic body weight. DCP and TDN of the fodder was 7.10% and 52.25% respectively. The experimental animals were in positive nitrogen, calcium and phosphorus balance. Thus NB-21 variety of hybrid Napier grass could only meet the digestible protein requirement of the goats and there was a need for supplementary feed to meet the deficit in energy requirement.

Genetic improvement of Sikkim local goat for litter size

Sikkim local goat is extremely important in providing livelihood security to a large number of small & marginal farmers and landless labours in the state. One of the important traits of this breed is high prolificacy, where the twinning and triplet characters can be improved through selective breeding and feeding management. For this purpose an elite herd of Sikkim local goats (48 female and 12 buck) were procured from different localities of the state. To protect animals from inclement weather all precautionary measurement were taken, The productive & reproductive parameters, health control measures including deworming, anti tick bath and general treatment were taken. The growth and bio-metrical parameters was also studied.

A total of 18 kidding were recorded during the year. The highest kidding incidence was found in April and October (22.78%) followed by September (16.675 %) and May (11.11%) respectively. It has been observed that a maximum female comes in heat in the month of May and June during the year.

A total of 18 kidding were obtained from Sikkim local goats with a twinning incidence of 39 %. Out of 18 kidding, 4 females were primiparous. In first kidding, 99% females gave single

birth. The over all sex ratio of male and female was 1 : 2.13. However, it was slightly higher in twins (1: 2.5) and slightly lower in single kidding (1: 1.75).

Reproductive and productive performance of Sikkim local goat

Data on reproductive performance of Sikkim local goat was recorded during the study period. Age at first service (days), weight at first service (kg), age at first kidding (days), weight at first kidding (kg), Gestation period (days), service period (days) and inter-kidding interval (days) were to be 361.33 ± 4.67 , 14.17 ± 0.44 , 509.33 ± 4.79 , 18.77 ± 0.65 , 145.78 ± 0.79 , 184.24 ± 1.50 and 241.56 ± 9.67 respectively.

The overall average body weight of male and female kids at birth was found to be 1.55 ± 0.08 and 1.37 ± 0.06 kg respectively. The body weight at birth was highest in single male and female kids (1.63 ± 0.15 and 1.60 ± 0.06 kg) with overall 1.61 ± 0.06 kg followed by twins male and female kids (1.48 ± 0.08 and 1.21 ± 0.05 kg) with overall 1.29 ± 0.05 kg respectively. The overall average body weight at birth of kid (male and female kid) was 1.43 ± 0.05 kg. The single male kids was heavier (1.63 ± 0.15 kg) than single female kid and twins male and female kids. The twins' male kids were heavier than twin female kids but inferior to single female kids.

The overall average body weight at 3 months of age was 5.65 ± 0.42 kg, however body weight was higher (6.20 ± 0.07 kg) in male kids in comparison to female kids (5.10 ± 0.05 kg). After 3 months of age all the kids were separated from the mother and single male kids were castrated for meat production. The average body weight at 6 months of age in male and female kids was 10.25 ± 0.22 and 8.75 ± 0.42 kg. with overall average body weight of 9.50 ± 0.51 kg respectively. The average body weight of male kids was higher after castration.. The litter size at birth was 1.41.

Biometrical studies of Sikkim local goats

The body height, body length, hearth girth and abdominal girth in male kids at birth was ranged from 20.5 - 27 cm, 19-26 cm, 19-24 cm and 18-26 cm with an average 23.63 ± 0.89 , 22.25 ± 0.96 , 22.13 ± 0.74 and 22.88 ± 0.97 cm and in female kids ranged from 19-26 cm, 20-25 cm, 18-28 cm and 18-26 cm with an average 21.24 ± 0.58 , 21.71 ± 0.49 , 20.71 ± 0.73 and 21.24 ± 0.62 cm respectively. The same parameters in male kids at 3 months of age were found to be 39.17 ± 0.91 ,

35.17±0.98, 38.33±0.76 and 40.17±1.43 cm and in female kids were 32.56±1.06, 31.00±1.01, 31.22±1.38 and 33.00±1.42 cm respectively. It was observed that body height, body length, hearth girth and abdominal girth in single male kids at birth and 3 months of age was higher (25.25±1.03 and 40.33±1.20 cm), (22.50±1.32 and 34.33±1.76 cm), (23.25±0.48 and 38.00±1.00 cm) and (24.00±0.71 and 41.67±1.67 cm) in comparison to twins male kids (22.00±0.91 and 38.0±1.15 cm), (22.00±1.58 and 36.20±1.00 cm), 21.10±1.22 and 38.67±1.33 cm) and 21.75±1.75 and 38.67±2.33 cm) respectively.

The gain in body height, length, hearth girth and abdominal girth (cm) from birth to 3 months of age in male kids was 11.47±0.46, 10.80±0.66, 9.56±0.36 and 9.96±0.65 cm and in female kids was found 10.46±0.04, 10.10±0.28, 9.26±0.26 and 9.12±0.17 cm respectively.

Effect of probiotic supplementation on growth of Sikkim local goats

Twelve female of 5-6 months old were selected from the herd of Goat Research Unit having initial body weight of 8.5±0.11 kg. Goats were randomly divided into two groups comprising of 6 goats in each. After completion of 2 months experiment, the body weight in control and treated group was recorded 10.25±0.16 vs. 14.50±0.21 kg respectively. Body measurements of the goats in probiotic-supplemented group was higher as compared to control group with significant differences.

Milk production and composition in Sikkim local goats

Data on milk production and composition were collected on 16 Sikkim local goats during the reported period. The milk production per goat ranged from 50-75 ml/day. The results obtained on total milk yield/lactation, lactation length and average milk yield/day. The total milk yield/lactation ranged from 12-42 litters with an average 39.45±3.89 lts. The lactation length varied from 90-126 days with an average 96.50±1.32 days. The milk samples from Sikkim local goats were collected in the morning and analyzed for fat, SNF, total protein and lactose at various stages of lactation and the average values were recorded to be 4.41±0.38%, 9.37±0.26%, 3.64±0.12% and 5.03±0.11% respectively. The milk yield and composition depends on fodder availability and stage of lactation of the animals. It was also observed that milk production in some females particularly in triplets mothers was not sufficient for kids and milk was offered

from other female or cow milk to the kids. Milk production in first lactating mother was also recorded very less even not sufficient to kids.

Management of dairy unit

The herd strength ranged from 27 to 33 during the year. Milk production varied from 60 liters in December 2011 to 120 liters in the month of May, 2011 per day. All the animals were maintained on green fodder through out the year. During rainy season (April to October) animals were maintained on hybrid napier, maize (*Zea mays*), rice bean (*Vigna umbellata*) and Jungle grasses and in winter (November to February) known as lean period maintained on oat (*Avena sativa*), tree fodder (*Ficus hookerii*, *Saurauia nepalensis*, *ficus religiosa*) and broom grass (*Thysanoleana agrostis*). Fresh water was made available during all the time. All the animals were protected against contagious diseases like FMD and tested for TB and Brucellosis disease in a regular fashion at periodical interval. The pregnancy diagnosis was done after 3 months of artificial insemination. The pregnant animal was dried off for 2 months before calving. The extra care was taken of pregnant animals and new born calf also. Dehorning was done at the age of 7 days. Weaning practice was not followed but calf removed from mother after 3 to 4 months of age.

Some time chaffed paddy straw was also procured from locality or ICAR farm or from Siliguri. The concentrate mixture offered to all the animal as per requirement of the animals. The concentrate mixture composed of crushed maize, mustard oil cake, wheat bran, mineral mixture and common salt. Concentrate mixture offered two times a day at 9.30 am and 2.30 pm. All precautionary measures were taken to protect animals from inclement weather. For artificial insemination, good quality semen straws were collected from state Govt

To provide green fodder during lean period, two forage block (*Ficus* and *Ficus* and Broom grass) were maintained under Dairy Unit. To meet the requirement of fodder in winter season (lean period), approximate 500 tree fodder (*Ficus hookerii*) and (*Saurauia nepalensis*) were transplanted under Dairy Unit. In some area, broom grass (more than 500 shoots/roots) also transplanted in the month of May 2011.

Management of pig unit

Pig husbandry has manifold contribution of food, fuel, fiber, etc. in the rural economy of state, because farmers are essentially following the mixed farming combining agriculture and livestock in the state. First time a small Pig Production Unit (PPU), 1 male and 4 females of Hampshire breed was maintained at ICAR Research Complex for NEH Region Sikkim Centre, Tadong, Gangtok. The unit was started from the month of April 2011. All the animals were maintained on concentrate mixture through out the year. The concentrate mixture composed of crushed maize, soybean cake, wheat bran, mineral mixture and common salt. Concentrate mixture offered two times a day at 9.30 am and 3.30 pm. During rainy season little amount of some jungle grasses were offered to all the animals and in winter Escus, Collocasia, Tapioca and leaves of cabbage and Broccoli cut into small pieces and mixed with concentrate mixture for reducing feed cost. All precautionary measures were taken to protect animals from inclement weather. During winter season extra care was taken to protect animals from severe cold. The body weight of pigs was recorded at the interval of 30 days in the morning before offering feed and water to the animals. Other reproductive parameters like Age at first service, weight at first service, Age at first farrowing, weight at first farrowing, litter size at birth, litter weight at birth and gestation period etc.were also recorded during the year.

EXTENSION ACTIVITIES

Training conducted

1. A 14, days training programme on “Scaling up of water productivity in Agriculture for livelihood through training cum demonstration” (SWAPL) from 16-29th Aug, 2011.
2. A 5, days training programme on (SWAPL) 16th to 29th Sep. 2011.
3. One day integrated fish production in horticulture based farming system during training programme under SWAPL on 24th Aug 2011.
4. A training programme on soil and water conservation in watershed Aug 29th to – 1st Sep 2011.
5. A 3, days training programme organized entitled “Scientific Goat Farming for the Farmers of Sikkim” from 2nd to 4th Sep 2011

6. A 3, days IGNOU Sponsored training on “Scientific Goat Farming” from 02nd -04th Sep, 2011.
7. A training cum awareness programme on protection of plant varieties and farmers’ rights, on 7th Apr,2011
8. A 9, days training programme on “Integrated Livestock Farming “sponsored by State Institute of Capacity Building, Karfectar, South Sikkim, from 23-11-11-to 01-12-2011
9. DMR sponsored training programme on new technologies in maize production under TSP during 23-24th March 2012 organized



Fig 11 Activities under TSP