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Farming Systems Approach for Managing Soil, Water and Crop in Coastal Areas

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Crop, livestock and fish cannot be separated for small holder agriculture in coastal areas of India as crop + livestock is the pre-dominant farming system existing in the country and livelihoods of 117 million marginal and small farm holdings revolves around this system. Integrated Farming System (IFS) is considered to be powerful tool and holds the key for ensuring income, employment, livelihood and nutritional security in a sustainable mode for small and marginal farmers who constitute 85 % of total operational holdings and has 44 % operational area. Integrated system meets the above goals through multiple uses of natural resources such as land, water, nutrients and energy in a complimentary way thus giving scope for round the year income from various enterprises of the system. The initial results of on farm farming system modules evaluated in various NARP zones through AICRP on Integrated Farming Systems promises 6.8 times increase in net returns over variable cost of interventions in improved farming systems with value of household consumption (produced within the farm) increasing by 51 %. Further, the per day profit of marginal and small households can be increased by 69 % through low cost interventions such as improved varieties, balanced recommended nutrient application, integrated pest management, good quality round the year fodder supply, area and species specific mineral mixture supplementation in feeds, cleaning /grading of farm produces and kitchen gardening in farming systems perspective. Additional employment of 54 man days/ year can also be generated for the household through these interventions. Land manipulation based farming systems are found to be highly beneficial for coastal areas in managing the soil, water and crop effectively.

(Key words: *Land configurations, Farming systems, Coastal areas)*

India has about 9000 km long coastline encompassing eight states and about 20% of the population of India live in coastal areas. Livelihood of people in coastal regions mainly depends on agriculture and its allied activities. However, the farming in this part is often vulnerable to natural calamities in the form of cyclones and *Tsunami*. The vast arable land adjacent to this coastline perpetually faces the problems of water logging and salinity. The occurrences of moderate to heavy cyclones are common almost every alternate year in the coastal states. Such cyclones cause seawater inundation of agricultural land, adding further salts to the already saline land. As a result, the agricultural productivity of the arable coastal lands has been generally low, causing the agriculture-dependent community to slide below the poverty line. The frequency of occurrences of cyclones, high tides and other disastrous events do not allow the coastal population to grow above the base of the poverty line.

Rice is the major crop in the coastal region. In addition, horticultural crops and plantations, especially coconut predominate coastal agriculture. The Major constraints in coastal agriculture are post monsoon dryness, water logging during the monsoon and coinciding of harvesting with pre monsoon showers. The paper described the land configuration based farming systems approach for mitigating the constraints and to improve the productivity in the coastal areas.

Farming Systems

Farming systems is a decision making unit comprising the farm household, cropping and livestock system that transform land, capital and labour into useful products that can be consumed or sold. All the components of the farming system interact adequately with environment without dislocating the ecological and socio- economic balance on the one hand and attempt to meet the national goal on the other. Integrated farming

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systems consider the concept of balanced input and output relationship and expected produce more when all the components are synergised. Farming systems research is defined as "a highly location specific research which represents an appropriate combinations of farm enterprises *viz.*, cropping systems, livestock, fisheries, forests, poultry and the means available to the farmers to raise them for profitability". There are two clear cut approaches which can be practiced to improve the profitability of the farm households and these include holistic and innovative approaches. Holism defined in the web as a Greek word meaning *all*, *whole*, *entire*, *total* is the idea that natural systems (physical, biological, chemical, social, economic, mental, linguistic, etc.) and their properties should be viewed as a whole, not as collections of parts. This often includes the view that systems function as a whole and their functioning cannot be fully understood solely in terms of their component parts. In a simple way, holistic approach means improving the productivity of existing components of the farming system in a holistic way. Innovative approach of farming system involves the improvement of existing farming systems with per captia based new introduction of components for increasing the profitability.

Water harvesting and recycling: A key to success of farming systems

The production system adopted during green revolution was explorative and the natural resources like soil and water were subjected to immense pressure beyond carrying capacity (Mahapatra *et al.,* 2007). Farm ponds may store *in-situ* rainfall or harvest surface runoff from surrounding areas depending upon the available rainfall in a region. In high rainfall areas, like A&N Islands where average annual rainfall is about 3100 mm, even *in-situ* rainwater storage in farm pond serves the purpose. A comprehensive work on rainwater management in Sundarbans delta, West Bengal is presented by Ambast *et al.,* (1998) which indicated considerable scope of excess rainwater storage in on-farm reservoir (OFR). Excess rainwater available during May to December in A&N Islands should be stored *in-situ* or harvested in the dugout farm ponds to provide supplemental irrigation in dry spells during rainy season and life saving irrigation for crop cultivation during dry months.

Multi Enterprise Farm Pond based system for coastal degraded lands

Harvesting of rainfall and surface runoff from surrounding areas are the major objectives of farm pond with the aim of recycling the water for crops, animals during dry season. In the process, multi enterprise farm pond based production system can be developed to ensure multiple uses of water and income from components. Due to the factors of soil salinity and back waters in coastal areas especially in the forthcoming scenario of climate change having the influence of sea level rise, the farm ponds in coastal/degraded lands are expected to have either fresh or brackish water. In brackish water based farming system, apart from saline tolerant lines of rice up to an extent of 6 dS m^{-1} of electrical conductivity, ducks can serve as an important component as no mortality was observed when introduced gradually to saline water of different concentrations up to 15 ppt. The body weight recorded at different week intervals do not pronounce much difference in different concentration of salinity for a period of one, two and three week's interval. Additional return of Rs. 4000 from 600m^2 pond can be obtained from the duck component within four months through sale of eggs for ensuring rotational livelihood of farmers especially in the disadvantaged areas having coastal salinity as a constraint. Saline tolerant fodders can also be grown on the bunds of farm pond to support livestock production (cattle & goat). Brackish water prawn can be reared in the ponds. After testing the water quality in the pond, water can be utilized for irrigation during dry period (Ambast *et al.,* 2011).

Rice based farming systems

Having the world's largest area devoted to rice cultivation at 42 million ha, India produces a considerable amount of fish from its rice fields. A report on the status of rice-fish farming in India indicates that India has rice-fish farms covering 2 million ha, which is the largest reported area for rice-fish culture for a single country. Rice-fish farming is considered an age-old tradition in the states of West Bengal and Kerala, but it is limited to capture systems in the Ganges and Brahmaputra plains. The practice cuts across different ecosystems, from the terraced rice fields in the hilly terrain in the north to coastal *pokali* plots and deepwater rice fields. In between are the mountain valley plots of north eastern India and rainfed or irrigated lowland rice fields scattered all over India. The species involved are just as diverse with over 30 species of fin fish and some 16 species of shrimps listed as being cultured in Indian rice fields. Most of the non-carp species and penaeid shrimp species

are from natural stocks entering the rice field with the floodwaters. Production rates are varied, ranging from 3 kg ha^{-1} $year^{-1}$ in the deepwater rice plots relying on natural stock of mixed species to over 2 t $ha^{-1}year^{-1}$ of Tiger shrimps (*P. monodon*) in shallow brackish water rice fields (Ghosh, 1992). Rice-fish farming in rainfed lowlands, rice based integrated farming system models for marginal farmers of Tamil Nadu, small farmers of Odisha, Integrated rice based farming system for north eastern plain zone and Broad Bed and Furrow (BBF) based farming system of rice + vegetables + fish in coastal waterlogged areas are the few well documented models which can ensure livelihood of farmers under changed circumstances of climate especially with expected deterioration in quality and quantity of water, micro climate of growing environment and inundation of rice fields with sea water in coastal areas due to rise in sea level.

Rice-fish + azolla system

The dual culture method of growing azolla with rice can accumulate 2 to 4 kg of N ha^{-1} day^{-1}. Azolla improves the fish feed availability in rice field. The field experiment conducted at Bhavanisagar of Tamil Nadu on rice-fish-azolla farming, rice-rice-fish+azolla system with 75 % recommended dose of N as well as incorporation of green leaf manure resulted in higher productivity with increased net returns and improved soil fertility through recycling of organic residues (Balusamy, 1996). The unutilized fish feed, decayed azolla and fish excreta settled at the fish trench bottom had a higher nutrient value, which can be recycled to enrich the soil.

Reduction of methane release in rice field through rice-duck system

Rice-duck farming system is a traditional practice in some of the Asian countries and duck farming is closely associated with wetland rice farming (Panda, 2004). The duck integration in rice field increases the rice yield by reducing weed growth, insect population, improving soil physical properties and thereby root growth and tillering. It also increases the dissolved oxygen content in rice field. However, ducks in rice farming reduces the greenhouse effect; prevent the release of methane gas which is important to check global warming. Duck provides additional benefit in terms of egg and meat to the small land holders apart from the environmental benefits.

IFS for marginal and small farmers of coastal areas

The land based enterprises such as dairy, poultry, fishery, mushroom, biogas etc were included by Behera and Mahapatra (1999) to complement the cropping programme to get more income and employment for small farmers of Odhisha. A net return of Rs 58367 can be realized with an investment of Rs 49286 in 1.25 ha area which also generated 573 man days of employment with a resource use efficiency of Rs 2.18 Re^{-1} invested thus ensuring the livelihood of small farmers (Table 1).

Table 1. *Rice based farming systems for increasing income and employment of small farmers (1.25 ha) at Odhisha*

Components	Total Expenditure (Rs)	Net retruns (Rs)	Return/ Re invested	Employment generation (man days)
Field crops	3315	5638	2.70	98.2
Multi-storeyed cropping	3831	9089	3.37	87.0
Pomology	900	1466	2.63	18.4
Olericulture	3812	8302	3.18	96.4
Floriculture	125	100	1.80	4.0
Pisciculture	3722	16603	5.46	31.0
Poultry	9240	981	1.11	23.0
Duckery	5387	713	1.13	23.0
Mushroom	18184	12856	1.70	180.0
Apiary	170	1180	7.94	1.0
Biogas	600	1431	3.38	11.0
Total	49286	58360	2.18	573.0

Behera and Mahapatra (1999)

On-Farm farming systems study in coastal areas with holistic approach

The study of 12 households in south 24 Paragnas district of West Bengal (Table 2) covering the coastal saline zone (WB-6) reveals that average holding size is 0.61 ha and intervention in crop and processing module are found to be significantly higher while livestock module is found to be non-significant for all the parameters. The low cost interventions in existing system resulted in 4 time increase in returns over variable coast of interventions. The cost of interventions in various modules of improved farming system ranged from Rs 997 to 2129 for 0.61 ha area. The total cost in improved farming system increased by 11.8 % while net returns rose by 91.2 % due to the intervention in crop, livestock, processing and optional modules. The value of household consumption was Rs. 27964 in improved farming system. Farming system intervention, doubled the per day profit of household besides generating additional employment of 18 man days. Similarly, the average holding size of experimental household was found to be 0.69 and 1.02 ha for marginal and small holders in Kendrapara district of Odisha. An additional gross return of Rs 26607 is possible with investment of Rs. 12881 in 0.91 ha. The total cost increased to 32% in improved farming system while total returns increased by 65% compared to existing farming system. Additional per day profit of Rs 37 and household employment of 31 man days/year can be obtained through low cost interventions in farming system mode.

The average holding of experimental household of Sivagangai and Pudukottai districts of Tamil Nadu was found to be 0.46 and 1.4 ha for marginal and small holders. A phenomenal increase of 43 times increase in net returns over variable cost was observed which is mainly due to reduction in cost of crop module to the level of Rs. 7688 attributed to introduction of SRI method of rice cultivation which saved input cost in terms of seed, labour besides increasing yield. The interventions in crop, livestock, processing and optional module resulted in additional return of Rs 19600, 3667, 1794 and 1575 respectively from 0.93 ha. Returns over variable cost per rupee invested increased to Rs. 4 in improved farming system compared to 0.57 in existing system. However, reduction in employment of 26 man days/ year was observed in crop module while livestock and optional registered additional man days of 18/ year for household employment. The holding size of experimental households in Srikakulam district of Andhra Pradesh was found to be 0.92 and 1.9 ha for marginal and small holders. The net returns over variable cost from interventions were observed to be Rs 2230 against the cost of interventions of Rs 3732 from 1.41 ha area. Additional net profit of Rs. 6/day and household employment of 21 man days/ year are recorded with improved framing system.

Climate smart crop-fish system

Climate-smart good practices seeks to increase productivity in an environmentally and socially sustainable way, strengthen farmers' resilience to climate change, and reduce agriculture's contribution to climate change by reducing greenhouse gas emissions and increasing carbon storage on farmland. Improving the access to and adoption of water conserving practices can help crop-fish systems to cope with lower water supply. Improving the reliability of the water supply through support for the construction of diversionary structures and holding ponds for rainwater harvesting is one example which can be utilized in rice-fish system. Use of marginal water sources (brackish water, treated and non-treated wastewater) can be an effective way to cope with lower rainfall. Blending good and poor-quality water to extend water supplies is the another strategy. A range of water management practices for crop-fish system are available to strengthen resilience to climate variability. Crop-fish integration in the unlined on-farm reservoirs is technically feasible and economically viable as compared to lined system for increasing the agricultural productivity. The water productivity and farm income was higher in crop-fish system in comparison to the sole system of any of these two independent methods (Sinhababu, 1996). Integration of fish in pond and vegetables in dykes or farm bunds of rice field further increases the water productivity.

Rice + vegetable + fodder + fish systems for high rainfall areas

This system can serve as climate resilient practice in the rice based farming systems especially in the coastal areas where in inundation of rice fields are expected due to the sea level rise. It is a technique of land manipulation to grow vegetables, fish and fodder together right in the midst of rice fields. The system is found to increases cropping intensity from the present level of 100% in the rice to 300% in the beds and 200% in the furrows of the BBF system besides, reducing the salinity problem in degraded land & water. Net return of Rs. 1.2 lakhs year^{-1} can be obtained from one ha area (Ravisankar *et al.*, 2010).

Table 2: *Improvement of net returns, per day profit and employment in improved farming systems in various coastal areas (All values are calculated over existing farming systems)*

ACZ	NARP zone code	District (State)	Holding size (ha)	Improved farming system module/model	Cost of interven-tions (Rs.)	Increase in net returns over variable cost of interven-tions (no. of times)	Increase in per day net profit (%)	Increase in household employment (man days)
Lower Gangetic Plains	WB-6	24 Paragnas South (WB)	0.61	Crop (CZn +LT+ OP+ GM+ BNA) + cow/goat/ poultry/ducks (RYFS +BN+ Vacci.) + fish	4814	4.0	93.2	18
East Coast Plains and Hills	OR-4	Kendrapara (Odisha)	0.91	Crop (IV + BNA + IPM + ST)+ cow/goat (AI + MM + Azolla + Vacci.+ BYP) + CAG + papad + chips + SS + cheese/ghee + NKG + mushroom + VC+ fish	12881	1.1	63.8	31
	TN-5	Sivagangai (TN) & Pudukottai	0.93	Crop (IV + SRI + BNA + IWM + IPM)+ cow (AI + RYFS + MM + DW + BYP) + CAG + NKG + VC	616	43	46.5	-8
	AP-2	Srikakulam (AP)	1.41	Crop (GM + IV + BNA +Dfn.) + buffalo/cow (RYFS + Azolla + poultry)	3732	0.6	100.0	21

* Note:

M1: IV: Improved variety, BNA: Balanced nutrient application, Dfn.: Diversification, PDM: Pest and disease management, CZn: Chelated zinc, LT: Line transplanting, OP: Optimum population, GM: Green manure, MN: Micro nutrient, IPM: Integrated Pest management, ST: Seed treatment, SRI: System of Rice Intensification, LS: Line sowing, SC: Seed compaction

M2: AI: Artificial Insemination, RYFS: Round the year fodder supply, MM: Mineral Mixture, Sani : Sanitation, DW: Deworming, BN: Balanced nutrition, Vacci: Vaccination, BYP: Backyard poultry, CMP: Clean milk production

M3: CAG: Cleaning and Grading, SS: Seed storage, SEM: Sale of excess of milk through co-operative union, VC: Vermicompost, VW: Vermi wash

M4: NKG:Nutritional Kitchen Garden, CC: Composite culture, VC: Vermicompost

Three tier system of fish-rice-vegetable farming

It involves the shaping of low lying land into three equal portions as pond, original or mid land and raised land. Pond area should be downward side of slope. The dug out soil from the pond area should be taken to upper side of slope for raising the land. The pond can be used water harvesting during rainy season, fish cultivation & supplemental irrigation. Stored fresh water in midland and pond keep field relatively salt free. Pond also creates better drainage to mid /raised land to prevent damages of crops due to occasional heavy rains in dry season. During wet season, paddy can be grown in the mid land along with vegetables on the raised bed. The system is in practice at coastal areas where in water logging is the major limitation for crop production.

Comparative performance of various systems

Comparative performance of various systems or technologies evolved and tested over the years in terms of net returns and B:C ratio at Andaman and Nicobar Islands are presented in Fig 1. Net returns from various systems and technologies identified through research are ranging from Rs. 13257 to Rs. 164960/ha over the traditional practice of monoculture of paddy with C 14-8 variety. Improved high yielding long duration variety of paddy followed table purpose groundnut can lead to return of Rs. 72000/ha. In the case of double cropping of paddy, the return from investment is lesser compared to mono-crop of paddy with improved high yielding late duration varieties.

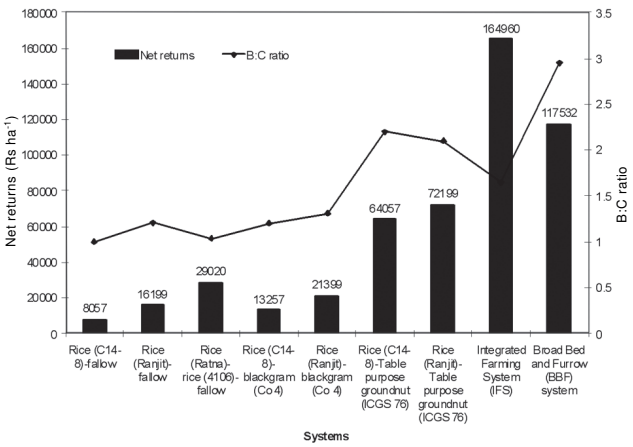

Fig. 1. Comparative performance of various systems in the coastal areas of Andaman and Nicobar Islands in terms of net return and B:C ratio

Coastal agriculture has the onus of providing livelihood to the 20 % of Indian population. The water logging and coastal salinity are the major factors affecting the agricultural output from the regions. Land configuration based farming system models are very important and gives scope for enhancing the profitability from agriculture and decent livelihood besides offering scope to grow many crops and fishes in the same piece of land. Raised and sunken beds, three tier systems, improved farming system packages and farm pond based production systems from the degraded lands are some of the examples of successful farming system models for the regions.

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Reclamation, Management and Production Potential of Coastal Saline Soils of Maharashtra

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The extent of coastal saline soils are 65,000 ha in Maharashtra. Low productivity of coastal saline soil is mainly due to salinity, even though the soils are fertile. The reclamation of coastal saline soil can be carried out by providing and maintaining embankment, surface, subsurface drainage, providing surface dugout ponds and cultural practices. Salt removed by sub surface drainage revealed that salt removal was related to spacing of drains, closer the drains more salt removal. Due to construction of dyke, excavating the drains, horizontal and vertical desalinization reduces soil salinity. Salt tolerant rice varieties PNL – 1, 2, 3 are adopted by farmers of the region. Application of recommended NP + 15 t ha^{-1} FYM produced significantly higher rice yield and help to reduce soil salinity. Application of organic manures, green manures observed to reduce the adverse effect of salinity on crop. Application of Urea, DAP briquettes found beneficial in reducing the N and P dose by 50%. The stored rainwater in surface dug out pond can be used as protective irrigation for short duration and salt tolerant crops like spinach, radish, mustard, linseed, sugar beet, tomato, cucurbitaceous vegetables and to reduce soil salinity. Simultaneously culturing fish in field and in the ponds is extensively adopted and proving profitable farming in the region.

(Key words: *Saline soils, Embankment salt removal, Drains, Desalinization, FYM, urea DAP briquettes, Salt tolerant crops, Culturing fish, Ponds, Profitable farming)*

According to the latest information available, the extent of coastal salt affected soils is 3.1 mha. in India out of which 65, 000 ha occurs in Konkan. Low productively of coastal saline soil is mainly due to salinity, even though the soils are fertile. The Konkan region is a long narrow strip, running north to south along the Western Coast of India. The region comprises five districts. viz. Greater Bombay, Thane, Raigad, Ratnagiri and Sindhudurg. The region has a hilly terrain and receives heavy and assured rainfall ranging from 2500 to 4000 mm per annum mostly during monsoon. The climates are warm and humid throughout the year. Rice based cropping system is followed in northern Konkan coastal zone and horticultural based cropping system is followed in southern Konkan coastal zone. The coastal region of Konkan is spread over 720 km in length represents great diversity with respect to soil and land use (Kadrekar, 1994).

Soil constraints mainly moderates to low base status, salinity at creeks, flooding during high tide, severe erosion, excessive runoff, shallow soil depth. The major problems encountered in coastal lands are sea water intrusion, impeded drainage, poor moisture retention, leaching, poor base status, low fertility, iron toxicity, salinity. The temperature rise is bound to affect tropical agriculture in general and rice in particular, because of consequent effect on the sea level. The sea level rise due to thermal expansion and ice melt expected to flood all low lying coastal area. The inundation being due to sea water added problem of salinity would prove a serious constraint to rice production. In general, the agricultural problems are tidal water inundation, heavy rainfall, dry spells during crop period, poor drainage, flat topography, high water table, non availability of good quality ground water and capillary rise of salts accumulate to surface cause the salinity. The salinity of soil is attributed to the inundation of the land with sea water during high tide and ingress of sea water along the estuaries, creeks, drains and rivers. Secondly, underground water table is present shallow depth enriched with high salt content. Salts accumulate on the soil surface due to capillary rise of saline ground water during dry period of the year. The entire area is almost mono cropped, the only crop being grown is rice in the monsoon period. During rest of the year the land remain fallow due to lack of good quality irrigation water and high soil salinity. High rainfall and impended drainage contribute to the serious problems of deep water submergence and water

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logging in the monsoon season. In view of above the problems the characteristics of coastal soils of Konkan region and its management options were presented based on the results of the experiment at Khar Land Research Station, Panvel.

MATERIALS AND METHODS

The experiments under study were conducted at Khar Land Research Station, Panvel. The soil of experimental site was clay loam in texture and pH 7.6, EC_2 10.8 dSm^{-1}, OC 1.2 g kg^{-1}, available P_2O_5 and K_2O were 35.92 and 1700 kg ha^{-1} respectively. The experiments on soil, agricultural engineering, agronomic and fisheries discipline were conducted following standard procedure and statistical method.

RESULT AND DISCUSSION

Due to relatively shallow saline water table and impeded drainage the average value of ECe of the soils is much higher (25 dSm^{-1}). The ECe of the soils gradually increase from surface downwards. The salinity of the soil varies with the season. It reaches its maximum in the month of May and decrease thereafter with the onset of monsoon. During pre-monsoon period the top soil layer is rich in salt while in the post-monsoon period the lower soil layer is enriched with salt. These soils are fairly well supplied with available plant nutrients. The micro-nutrients status of these soils is observed to be high.

Reclamation measures

Reclamation of the coastal salt affected soils can be carried out according to the local conditions by preventing the tidal water inundation through construction of bunds, leaching of salts from the soil profile and through application of suitable amendments, adoption of other suitable soil, water and crop management practices.

1) Protective Bunds – Embankment/dyke.
2) Sluice gate (a) Manual operated (b) Automatic.
3) Surface drainage.
4) Sub surface drainage. a) Open drains – 10 m b) Close drains c) Closed spaced drains – 20 m d) Back filled drains.
5) Surface dug out pond – Periodically pumping water reduce salinity.
6) *Ulkatni* – Turning clod upside down during summer.
7) Ploughing – During May.

Ingress control

A strong embankment is required to be constructed at least to a height greater than the height of maximum tide to stop ingress of sea water. Embankment with a 2:1 slope on creek side and 1:1 slope on inner side, sluice gate opening one way is recommended. Embankment with stone pitching with grass cover is very effective.

Drainage and desalinization

In order to remove excess salts by run-off without causing erosion of soil, deep drains of 1.5 to 2.0 m depth at 100 m drain distance were found effective. Closed spaced drains of 20 m spacing or open drains and back filled drains with the help of rain water is considered to be effective to remove the salt from surface soil. Surface dug-out farm pond showed added advantage of reclaiming an area upto a radial distance of 27 m by periodical pumping of saline water into the drain and flushing it out.

Tillage practices

The practice of *Ulkanti* was found to be equally effective when compared with shallow plouging. *Awatani* a local method was found to be superior to transplanting provided the plant population is maintained.

Salvi and Chavan (1983) reported that the occurrence of maximum dry spell of 30, 40 and 47 days during monsoon is expected within a period of 5, 10 and 20 years, respectively. The dry spells of 13, 17 and 31 days occurring in months of August, September and October, respectively, coincide with the important physiological stages of growth of rice such as maximum tillering, panicle, initiation, dough and growth filling stages during which the water requirement of rice is high . Salinization is more near to creek, however ground water salinity reported more than creek water (Anonymous, 1989). Salt removal by sub surface drainage revealed that salt removal is related to spacing of drains, closer the drains more salt removal (Anonymous, 1979). Due to construction of dyke, excavating drains horizontal, vertical desalinization etc. reduced soil salinity during pre monsoon and post monsoon from 23.27 to 9.68 and 19.57 to 7.34 dSm^{-1}, respectively (Anonymous, 1991). Popular rice varieties adapted to salinity stress are PNL – 1, 2, 3 and Kala Rata.

It was observed that 25 days old seedlings of Panvel-1 rice variety with four seedlings per hill and 100 kg N ha^{-1} gave optimum yield (36.45 q ha^{-1}). If the transplanting is delayed, 35 days old seedlings with six seedlings per hill and 150 kg N ha^{-1} need

to be planted. Spacing of 15 x 20 cm for Panvel - 1 and 15 x 15cm for Panvel - 2 varieties were found to be optimum. The very low hydraulic conductivity of the soil poses problem in the speedy reclamation by downward movement of salts. However, horizontal desalinization by flushing out of salts into the side drains with help of rain water is considered to be temporary measures which removes the salt form surface soil and makes it suitable for growing rice in *Kharif* season.

Nutrition management

Addition of organic material either in the form of FYM, compost or green manure reduces the adverse effect of salinity on rice crop. *Dhaincha*, *Shevari* and leaves of *Bhend* are found to be useful in increasing the yield of rice crop. Response of rice varieties to nitrogen was found to be quadratic. Use of Urea-DAP briquettes found to be very effective for saving nitrogen in rice cultivation in coastal saline soil. Chavan *et al.,* (1991) reported that use of FYM along with NP were beneficial. NP + 15 t ha^{-1} FYM produced significantly higher rice yield over other treatment indicated highest cost benefit ratio. They also reported that there is reduction is soil salinity, however, organic carbon per cent have been increased at the end of the trial. The effect of nitrogen, phosphorus and potassium levels on grain yield suggested that, there were no significantly influence of P and K or their interactions on grain yield of rice possibly due to high reserve of these nutrients in soil. Non response of P in water logged soil with high native source of same. Nitrogen has prominent effect in increasing the grain yield and there was significant response to nitrogen application.

Salt tolerant rice varieties

During early years Bhura Rata 4-10, Kala Rata 1-24, MK-47-22 and SR-3-9 varieties were released for costal saline soils. Rice varieties viz. Panvel-1, Panvel-2 and Panvel-3 were evolved and released as these varieties are highly salt tolerant and high yield potentials.

Rabi cropping

Crops like Radish, spinach, various cucurbitaceous crops, mustard, linseed, sugar beet and beet performed well during *Rabi* season with irrigating these crops with rainwater harvested in shallow farm ponds and construction of check dams. Protective irrigations were followed during *Rabi* season. There is scarcity of good quality irrigation water during *rabi* season in the costal belt of Maharashtra. The under ground water is brackish and not suitable for irrigation. However, this area receives very high rainfall. The rainwater can be harvested by excavating shallow farm ponds and construction of check dams. This stored water can be used for growing certain crops with protective irrigation. Many pulse, oilseed and vegetable crops and their varieties were screened for salt tolerance. The following crops performed satisfactorily. The *Ramonskaya* variety of sugar beet also performed well and yielded upto 28 t ha^{-1}. The nitrogen requirement of spinach (Var: All green) and radish (Var: Pusa Reshmi) was found to be 120 kg N ha^{-1} for getting optimum yields. Cultivation of various cucurbitaceous crops on field bunds was tested. The okra, cucumber, ridge gourd, sponge gourd and bitter gourd performed well on field bunds with an average yield of 0.485, 0.750, 2.030, 1.490 and 1.500 kg per plant, respectively.

Fish Farming

Use of costal saline area for agriculture alone has certain limitations. It has been estimated that out of 65,465 ha about 14,655 ha area can be utilized for fish and prawn culture. The marine fishing in Maharashtra has stabilized around three lakh tones for the last several years.

Rice-cum-fish farming

In the simultaneous farming of rice and fish *Cyprinus carpio* yielded from 138 to 286 kg ha^{-1}. The fish weight increased from 1.29 g at the time of release to 44 g at the time of harvest within 65 to 70 days.

Fish/prawn culture in brackish water/fresh water ponds

Jitada *(Lates calcarifer*) culture is fairly wide spread in the coastal area of the State and ranks second after Indian major carps in culture fisheries. After a period of 42.8 weeks with supplementary feeding, it yielded an average weight of 318.4 kg ha^{-1} and when Tilapia was used as forage fish an average growth of 570 g of Jitada in seven months was observed.

With the identical technique of phased fertilization, the fresh water prawn *Macrobrachium rosenbergii* grew to an average weight of 60 g in 15 weeks while the tiger prawn *Penaeus monodon* grew to an average weight of 43 g in 23 weeks. In nursery ponds at Pargaon, post larvae of *M. rosenbergii* were reared by administering different combinations of oil cake, rice bran and fish meal, when the maximum growth/survival was observed with 80% oil cake +

10% rice bran + 10% fish meal. The polyculture of *M. rosenbergii* with common carps resulted in an average weight gain of 125 g in a span of 25 weeks. These results reveal that is a potential for the above fish and prawn species in the fresh/brackish water ponds in the costal saline soils.

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Impact of Irrigation and Levels of Fertilizers Application on Zero Tilled Cowpea (*Vigna unguiculata* L.) Cultivation

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An experiment was conducted at Agronomy farm of Dr. B.S. Konkan Krishi Vidyapeeth, Dapoli during *Rabi* season of 2011-2012 to study the effect of irrigation and levels of fertilizer application on yield, quality and nutrient uptake of zero tilled cowpea. The experiment was laid out in split plot design with three replications. The main plot treatments were three irrigation levels *viz.,* no irrigation, one irrigation at branching and two irrigations at branching and pod filling stage. The sub plot treatments comprised six fertilizer levels *viz.,* no fertilizer, 25% RDF below seed placement, 50% RDF below seed placement, 75% RDF below seed placement, 100% RDF below seed placement and 100% RDF through line application. Results revealed that application of two irrigations (at branching and pod filling) recorded significantly higher grain yield, stover yield, protein content as well as N, P_2O_5 and K_2O content and their uptake followed by treatments in which one irrigation (at branching) and zero irrigation (control). Application of 100% RDF below seed placement recorded significantly higher grain yield, stover yield, protein content as well as N, P_2O_5 and K_2O content and their uptake followed by 100% RDF through line application, 75, 50, 25% RDF below seed placement and control.

(Key words: *Irrigation, Fertilizer, Zero tilled cowpea)*

Pulses are nature's precious gift to mankind. Cowpea (*Vigna unguiculata* L.) is a broadly adapted and highly variable crop, cultivated around the world primarily as a pulse but also as a vegetable, a cover crop and for fodder. In Konkan region of Maharashtra, pulses are mainly grown during *Rabi* season after harvest of rice crop both on residual moisture as well as under irrigation. The cultivation of cowpea in rice fallows is reported to be more profitable than horse gram and mustard (Kadrekar, 1990). Zero tillage or no tillage is a farming system in which the seeds are directly deposited into untilled soil which has retained the previous crop residues. It is also referred to as no-till. Zero tillage is cultivation practice that not only helps to preserve soil fertility and conserves scarce water, but boosts yield and increases farmer's profits by reducing their production costs. Zero tillage is a system of planting (seeding) crops into untilled soil by opening a narrow slot or trench only of sufficient width and depth to obtain proper seed coverage. No other soil tillage is done. Due to zero tillage the costs is reduced about 15 to 16 per cent. Zero tillage having positive environmental impacts in the Indo-Gangatic plains. It saves fossil fuels and reduces greenhouse gas emissions, and cuts water use.

The average productivity of pulses in Konkan found to be very low. Among various pulses, which are liked and relished by Konkan people is cowpea. The reasons for the low yield of cowpea grown on residual moisture in zero tilled condition are that cowpea hardly receives any irrigation at critical growth stages during hot weather. Another cause for low yield of cowpea is lack of suitable method and level of fertilizer application to crop grown on residual moisture. Therefore, to exploit high yielding potential of cowpea on residual moisture field experiment was conducted.

MATERIALS AND METHODS

A Field experiment was conducted at Department of Agronomy, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli during *Rabi* season of 2011-2012 to study the effect of irrigation and levels of fertilizer application on zero tilled cowpea. The soil of the experimental plot was uniform, leveled and well drained. It was sandy clay loam in texture, medium in available nitrogen (298.20 kg ha^{-1}), medium in available phosphorus (11.80 kg ha^{-1}), moderately high in available potassium (249.35 kg ha^{-1}), high in organic carbon (0.95%) and slightly acidic in reaction (pH 5.8). The

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experiment was laid out in a split plot design with three replications. The main plot treatments were three irrigation levels, *viz.,* no irrigation (I_0), one irrigation at branching (I_1) and two irrigations at branching and pod filling stage (I_2). The sub plot treatments comprised six fertilizer levels *viz.,* no fertilizer (F_0), 25% RDF below seed placement (F_1), 50% RDF below seed placement (F_2), 75% RDF below seed placement (F_3), 100% RDF below seed placement (F_4) and 100% RDF through line application (F_5). Thus, there were in all 18 treatment combinations. The treatments were randomized in the experimental units.

The experimental plot was left unploughed and was uniform in topography. The plots of 4.2 m x 3.3 m size were prepared and demarked manually. Under zero tillage condition, the fertilizers were applied uniformly to the whole plot in the holes dibbled earlier at the spacing of 30 x 15 cm. Whole quantity of fertilizers (25:50 kg NP ha^{-1}) was uniformly mixed and it was applied 3-4 cm below the seed to avoid the direct contact of seed with fertilizers. The calculated quantity of N and P_2O_5 was applied through urea and single super phosphate, respectively. After fertilizer application the seeds were sown in the holes dibbled. Two to three seeds were dibbled at each spot at about 5 cm depth. Seeds were properly covered with the soil to avoid the damage from birds. In the present investigation, irrigations were applied as per treatments at branching and pod filling stage to the respective plots, for that purpose irrigations were given to respective treatment plots by flexi pipe. In order to assess the effect of different treatments on the growth and yield of cowpea crop biometrical observations were recorded.

RESULTS AND DISCUSSION

Effect of irrigation on yield, N, P, K and protein content of cowpea

Data furnished in Table 1 stipulated that, various irrigation treatments significantly influenced the grain yield of cowpea. The irrigation treatment I_2 recorded significantly higher grain yield (12.26 q ha^{-1}) and stover yield (26.17 q ha^{-1}) than treatments I_1 and I_0. Similarly, treatment I_1 was found significantly superior over treatment I_0. The magnitude of increase in grain yield over I_0 (control) in treatments I_2 and I_1 was to the tune of 65.23 and 34.77 per cent, respectively and increase in stover yield over I_0 due to treatments I_2 and I_1 was to the tune of 59.48 and 29.25 per cent, respectively. The increase in grain and straw yield in treatment I_2 was mainly attributed due to higher moisture availability due to two irrigations at the critical growth stages (branching and pod filling) of cowpea. These results are in line with those reported by Asaduzzaman *et al.*, (2008) and Babar and Dongale (2011).

The N, P, K and protein content in grain was observed significantly higher under treatment I_2 than treatment I_1 and I_0. The higher N, P, K and protein content in stover was observed under treatment I_2 than treatment I_1 and I_0. The reason of highest content of N, P and K by the treatment application of two irrigation (at branching and pod filling stage) might be the supply of irrigation at crop growth stage provided adequate moisture supply in the soil, which plays an important role in nutrient uptake involving diffusion, mass flow and root interception. Protein content is computed by multiplying N content with factor 6.25. Similar findings were also be reported by Borse *et al.*, (2002) and Mondal *et al.*, (2005).

Effect of fertilizer levels on yield, N, P, K and protein content of cowpea

It was revealed from the data presented in Table 1 that fertilizer level F_4 recorded significantly higher grain yield (12.62 q ha^{-1}) than the treatment F_5 followed by treatment F_3 which were at par with each other but found significantly superior over treatments F_2, F_1 and F_0 i.e. control in that descending order of significance. Treatment F_4 recorded significantly higher stover yield (26.48 q ha^{-1}) followed by treatment F_5 which were at par with each other but found significantly superior over rest of the treatments. This was may be due to fact that, more amount of nutrients must be available to the crop due to fertilizers applied below seed placement compare to fertilizers applied through line application. These results are in line with those reported by Kumar *et al.*, (2002) and Singh *et al.*, (2006)

Different fertilizer levels significantly influenced the N, P, K and protein content of grain and stover. Treatment F_4 recorded significantly higher N, P, K and protein content followed by treatments F_5, F_3, F_2, F_1 and F_0 i.e. control in that descending order of significance. Higher amount of available soil nutrients increased absorption of plant nutrients, hence increased the value of N, P, K content in grain and stover. The content of N and P in seed was higher than that of stover which might be due to translocation of N and P to seed where these were accumulated in the forms of proteins. These results are in line with those reported by Reddy and Ahlawat (1998).

Table 1. *Effect of different treatments on yield, NPK and protein content of cowpea.*

Treatments	Grain yield (q ha^{-1})	Stover yield (q ha^{-1})	N content (%)		P content (%)		K content (%)		Protein content (%)	
			Grain	Stover	Grain	Stover	Grain	Stover	Grain	Stover
Irrigation levels										
I_0: Control	7.42	16.41	2.79	1.86	0.275	0.106	1.08	1.95	17.59	11.63
I_1: One irrigation	10.00	21.21	2.98	1.92	0.295	0.128	1.09	2.04	18.63	12.00
I_2: Two irrigation	12.26	26.17	3.20	1.96	0.300	0.157	1.11	2.11	20.01	12.24
F test	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.
SEm +	0.37	0.65	0.03	0.01	0.002	0.004	0.003	0.02	0.29	0.07
CD at 5%	1.45	2.56	0.10	0.04	0.009	0.016	0.010	0.08	1.14	0.27
Fertilizer levels										
F_0: Control	6.67	15.20	2.43	1.78	0.242	0.086	1.06	1.860	15.49	11.15
F_1: 25% RDF below seed placement	8.09	17.56	2.68	1.84	0.262	0.106	1.08	1.950	16.77	11.48
F_2: 50% RDF below seed placement	9.70	20.46	2.89	1.89	0.279	0.120	1.09	2.027	18.08	11.78
F_3: 75% RDF below seed placement	10.93	22.71	3.10	1.93	0.299	0.139	1.10	2.080	19.39	12.08
F_4: 100% RDF below seed placement	12.62	26.48	3.52	2.06	0.338	0.176	1.12	2.150	22.03	12.85
F_5: 100% RDF through line application	11.36	25.17	3.31	1.98	0.320	0.157	1.11	2.129	20.70	12.39
F test	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.
SEm +	0.41	0.75	0.07	0.01	0.006	0.008	0.008	0.02	0.42	0.09
CD at 5%	1.18	2.17	0.19	0.04	0.016	0.022	0.023	0.06	1.22	0.27
Interaction effect										
F test	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S
SEm +	0.71	1.30	0.18	0.03	0.010	0.013	0.01	0.04	0.73	0.16
CD at 5%	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S
General mean	9.89	21.26	2.99	1.91	0.29	0.13	1.09	2.03	18.74	11.96

Table 2. *Effect of different treatments on NPK uptake of grain and stover of cowpea*

Treatments	N uptake (kg ha^{-1})		P uptake (kg ha^{-1})		K uptake (kg ha^{-1})	
	Grain	Stover	Grain	Stover	Grain	Stover
Irrigation levels						
I_0: Control	20.70	29.83	2.040	1.700	8.01	31.28
I_1: One irrigation	29.80	40.91	2.950	2.728	10.90	43.47
I_2: Two irrigation	39.23	49.02	3.780	3.927	13.65	52.77
F test	Sig	Sig.	Sig.	Sig.	Sig.	Sig.
SEm +	1.22	0.83	0.134	0.020	0.38	1.41
CD at 5%	3.51	3.26	0.527	0.078	1.51	4.80
Fertilizer levels						
F_0: Control	16.20	29.48	1.614	1.424	7.08	30.80
F_1: 25% RDF below seed placement	21.68	33.73	2.119	1.943	8.73	35.74
F_2: 50% RDF below seed placement	28.03	37.61	2.706	2.388	10.57	40.39
F_3: 75% RDF below seed placement	33.88	42.02	3.268	3.026	12.02	45.28
F_4: 100% RDF below seed placement	44.42	50.99	4.265	4.356	14.13	53.21
F_5: 100% RDF through line application	37.60	46.35	3.635	3.675	12.60	49.86
F test	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.
SEm +	1.22	2.07	0.149	0.210	0.42	2.13
CD at 5%	4.57	5.97	0.432	0.605	1.24	6.15
F test	N.S	N.S	N.S	N.S	N.S	N.S
SEm +	2.74	3.58	0.26	0.363	0.74	3.6
CD at 5%	–	–	–	–	–	–
General mean	29.57	39.71	2.87	2.70	10.78	42.20

Effect of irrigation and fertilizer levels on N, P and K uptake

It is evident from the data presented in Table 2 that N, P and K uptake in grain and stover were significantly higher under treatment I_2 than rest of the treatments I_1 and I_0. Since uptake is a function of grain and straw yield and their nutrient content, the significant improvement in content of these nutrients coupled with increased grain and straw yield increased the uptake of nutrients substantially. These results are accordance with Borse *et al.*, (2002) and Mondal *et al.*, (2005).

N, P and K uptake in grain and stover of cowpea was significantly influenced due to various fertilizer levels under study. Significantly higher N, P and K uptake in grain and stover uptake of cowpea was found under fertilizer treatment F_4 followed by treatments F_5 F_3, F_2, F_1 and F_0 in that descending order of significance. The above observations are in accordance with Singh *et al.*, (2006).

CONCLUSION

From the results of the present investigation it can be concluded that, during *Rabi* hot weather season cowpea crop grown under zero tilled condition should be provided with two irrigations (at branching and pod filling stage) along with 100% recommended dose of fertilizer (25:50:00 NPK Kg ha^{-1}) applied below seed placement for obtaining higher yield and better quality from cowpea.

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Response of Cowpea (*Vigna unguiculata* L.) Varieties to Different Sowing Dates and Effect on Yield, Quality and Soil Fertility

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An experiment was conducted on coastal lateritic soil of Konkan region to study the response of cowpea (*Vigna unguiculata* L.) varieties to different sowing dates and effect on yield, quality and soil fertility during *Rabi*-hot weather season 2011-12 at Agronomy department farm, College of Agriculture, Dapoli. The experiment was laid out in a split plot design with three replications. The main plot treatments were five sowing dates, namely, sowing of cowpea in 48th MW, 50th MW, 52nd MW, 2nd MW and 4th MW. The sub plot treatments comprised three cowpea varieties *viz.,* Konkan Sadabahar, Konkan Safed and Phule Pandhari. Among the different sowing dates studied, 52nd MW recorded significantly higher yield, NPK and protein content over rest of the sowing dates. Among different cowpea varieties, Konkan safed recorded significantly higher yield, NPK and protein content over other two cowpea varieties. The soil available nitrogen, phosphorus and potassium after harvest of cowpea were not influenced significantly by both sowing dates and cowpea varieties.

(***Key words:*** *Cowpea, Sowing dates, Varieties)*

Cowpea (*Vigna unguiculata* L.) is the most important legume in the world. It is an important source of dietary protein in developing countries of Asia and Africa. It is used as fodder, vegetable pulse and green manure crop. The economic importance of cowpea is difficult to ascertain as the production statistics are no longer kept separate from those of other pulses. Summer cowpea is grown as catch crop in Konkan region in the areas where irrigation facilities are available.

Proper sowing time is the most important non-monetory input in crop production, which affects the crop growth, yield and quality to greater extent. Time of sowing plays an important role to fully exploit all available resources for growth as it provides optimum growing conditions such as temperature, light, humidity and rainfall. Sowing time determines time available for vegetative phase before the onset of flowering, which is mainly influenced by photoperiod. Delay or early sowing may or may not provide the optimum conditions of climate, which results in reduced growth and ultimately affect the yield and quality of produce. A small change in sowing time leads to significant changes in performance of crop.

Varieties play an important role in crop production and the potential yield of a variety within genetic limit is determined by its environment. The releases of high yielding varieties have contributed a great deal towards the improvement of cowpea yields. The yield potential of these high yielding varieties can be further exploited through better agronomic practices with respect to sowing dates. The yield of any crop depends on the production potential of the cultivar and climatic, edaphic and management practices to which the cultivar is exposed. In this context, the response of cowpea varieties to different sowing dates on yield, quality and soil fertility have been studied in Konkan region of Maharashtra.

MATERIALS AND METHODS

A field experiment on cowpea was conducted during *Rabi*-hot weather season 2011-12 at Agronomy Department Farm, College of Agriculture, Dapoli.The soil was sandy clay loam in texture, medium in available nitrogen (298.20 kg ha^{-1}) and phosphorus (11.80 kg ha^{-1}), high in available potassium (271.89 kg ha^{-1}) and moderately acidic in reaction (pH 5.8). The experiment was laid out in a split plot design with three replications. The main plot treatments were five sowing dates, namely, sowing of cowpea in 48th MW (S_1), 50th MW (S_2), 52nd MW (S_3), 2nd MW (S_4) and 4th MW (S_5). The sub plot treatments comprised three cowpea

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varieties *viz.,* Konkan Sadabahar (V_1), Konkan Safed (V_2) and Phule Pandhari (V_3). The gross plot size was 4.5 x 3.6 m^2 and net plot size was 3.9 x 3.0 m^2, respectively.

Well decomposed FYM and full dose of N and P_2O_5 were applied to each plot as per the recommendation (25:50:00 N, P_2O_5 and K_2O kg ha^{-1}) at the time of sowing. The healthy, unbroken and well developed seeds of cowpea varieties were treated with fungicide and biofertilizers (*Rhizobium* and PSB @ 25 g each kg^{-1} seeds) before sowing. The seeds of different cowpea varieties were sown at different sowing dates, *viz*; 2nd (48th MW), 16th (50th MW) and 30th (52nd MW) December 2011, 14th January (2nd MW) and 28th January (4th MW) 2012 as per the treatments. The other usual common packages of practices were carried out time to time and periodical growth observations were recorded at an interval of 15 days. Crop was harvested at physiological maturity and data on yield attributes and yield were recorded.

RESULTS AND DISCUSSION

Effect of sowing dates on grain and stover yield, N, P, K and protein content of cowpea

It is evident from the data presented in Table 1 that the sowing of cowpea in 52nd MW produced maximum and significant higher grain yield (12.86 q ha^{-1}) and stover yield (24.32 q ha^{-1}) over rest of the sowing dates. The magnitude of increase in grain yield recorded by sowing of cowpea in 52nd MW over the crop sown in 50th, 48th, 2nd and 4th MW was 8.34, 9.63, 11.73 and 21.90 per cent, respectively. The percentage increase in stover yield recorded due to the crops own in 52nd MW over 50th, 48th, 2nd and 4th MW was to the tune of 8.28, 9.30, 10.45 and 21.00 per cent, respectively. The increase in yield of cowpea sown during 52nd MW over rest of sowing dates was the result of increased growth and yield attributes. This finding resemble with the findings of Rajput (1994) and Ullah *et al.,* (1995).

The N, P and K contents in grain and stover of cowpea recorded under 52nd MW sowing date were significantly higher over 50th, 48th, 2nd and 4th MW. This might be due to better absorption of N, P and K by the crop. The results resemble the findings of Ram *et al.,* (1990) and Shinde (2009). The protein content of cowpea followed the same trend to that of nitrogen content in grain and stover as protein content is computed by multiplying N content with the factor 6.25.

Effect of cowpea varieties

It could be seen from Table 1 that the Konkan Safed variety of cowpea produced maximum and significantly higher grain yield (12.70 q ha^{-1}) and stover yield (25.09 q ha^{-1}) over other two varieties. The magnitude of increase in grain yield recorded by Konkan Safed over Phule Pandhari and Konkan Sadabahar was 8.36 and 19.03 per cent, respectively. The increase in stover yield recorded by Konkan Safed over Konkan Sadabahar and Phule Pandhari was 15.73 and 25.07 per cent, respectively. Increase in yields of cowpea variety Konkan Safed over other two varieties were the results of increased growth and yield attributes.The present results are in consonance with those of Birari *et al.,* (1993) and Malagi (2005).

The N, P and K content in grain and stover of different cowpea varieties was differed significantly. Konkan Safed recorded significantly higher N, P and K content in grain and stover. Further, variety Konkan Safed produced quality seed in terms of significantly higher protein content in grain and stover compared to Phule Pandhari and Konkan Sadabahar.The results resemble the findings of Nirmal *et al.,* (2001) and Makanur (2009).

Effect of sowing dates on N, P, K uptake and soil fertility status

The maximum uptake of N, P and K in grains, stover and their total was observed under sowing of cowpea in 52nd MW followed by 50th MW, 48th MW, 2nd MW and 4th MW in descending order, respectively. Since, uptake is a function of grain and stover yield and their nutrient content, the significant improvement in the content of these nutrients coupled with increased grain and stover yield increased the uptake of nutrients. The results resemble the findings of Ram *et al.,* (1990).

The uptake of N, P and K in grain, stover and their total were significantly higher under 52nd MW sowing over remaining sowing dates. Sowing of cowpea in 52nd MW produced quality seeds in terms of higher protein content in grain and stover of cowpea. The available N, P_2O_5 and K_2O content of soil after harvest of cowpea due to sowing dates were not influenced significantly. However, there was little improvement in N and P_2O_5 status compared to their initial levels, while, K_2O content was depleted as compared to its initial level as it was not supplied to the crop.

Table 1. *Effect of different treatments on yield, NPK and protein content of cowpea*

Treatments	Grain yield (q ha^{-1})	Stover yield (q ha^{-1})	N content (%)		P content (%)		K content (%)		Protein content (%)	
			Grain	Stover	Grain	Stover	Grain	Stover	Grain	Stover
Main plot: Sowing dates										
S_1-M.W.No.- 48	11.73	22.25	3.25	1.88	0.343	0.189	1.152	1.820	20.32	11.73
S_2- M.W.No.- 50	11.87	22.46	3.33	1.90	0.352	0.198	1.181	1.991	20.83	11.87
S_3- M.W.No.- 52	12.86	24.32	3.63	2.06	0.379	0.230	1.264	2.373	22.67	12.86
S_4-M.W.No.- 2	11.51	22.02	3.19	1.84	0.334	0.168	1.135	1.585	19.92	11.51
S_5-M.W.No.- 4	10.55	20.10	2.90	1.68	0.313	0.137	1.052	1.280	18.15	10.53
F test	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.
SEm +	0.28	0.58	0.08	0.04	0.006	0.008	0.018	0.091	0.50	0.27
CD at 5%	0.93	1.91	0.26	0.14	0.020	0.025	0.060	0.296	1.63	0.86
Sub plot : Varieties										
V_1:Konkan Sadabahar	10.67	21.68	3.14	1.72	0.332	0.169	1.080	1.633	19.67	10.79
V_2: Konkan Safed	12.70	25.09	3.44	2.01	0.358	0.202	1.228	1.992	21.50	12.57
V_3: Phule Pandhari	11.72	20.06	3.19	1.87	0.343	0.182	1.162	1.804	19.95	11.71
F test	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.
SEm +	0.21	0.48	0.079	0.035	0.004	0.005	0.017	0.056	0.49	0.21
CD at 5%	0.63	1.43	0.23	0.10	0.013	0.015	0.051	0.165	1.46	0.64
Interaction effect										
F test	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
SEm +	0.48	1.09	0.18	0.08	0.01	0.01	0.04	0.13	1.11	0.49
CD at 5%	–	–	–	–	–	–	–	–	–	–
General mean	11.70	22.28	3.26	1.87	0.34	0.18	1.15	1.80	20.37	11.69

Table 2. *Effect of different treatments on NPK uptake of grain and stover of cowpea and soil fertility status after harvest of crop*

Treatments	N uptake (kg ha^{-1})		P uptake (kg ha^{-1})		K uptake (kg ha^{-1})		Available N (kg ha^{-1})	Available P_2O_5 (kg ha^{-1})	Available K_2O (kg ha^{-1})
	Grain	Stover	Grain	Stover	Grain	Stover			
Main plot: Sowing dates									
S_1-M.W.No.- 48	38.19	42.03	4.03	4.22	12.39	40.99	308.06	13.07	263.95
S_2- M.W.No.- 50	39.72	42.80	4.19	4.48	12.97	44.61	307.29	12.62	261.20
S_3- M.W.No.- 52	46.79	50.26	4.88	5.60	14.42	53.15	302.22	12.22	256.97
S_4-M.W.No.- 2	36.71	40.70	3.86	3.70	12.05	37.36	309.64	13.20	265.18
S_5-M.W.No.- 4	30.60	34.28	3.30	2.81	10.43	28.49	312.60	13.97	268.55
F test	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	N.S.	N.S.	N.S.
SEm +	1.21	1.69	0.09	0.18	0.43	2.04	2.12	0.38	1.67
CD at 5%	3.94	5.50	0.28	0.59	1.40	6.64		–	–
Sub plot : Varieties									
V_1: Konkan Sadabahar	33.74	34.51	3.55	3.70	11.14	34.88	308.41	13.43	265.74
V_2: Konkan Safed	43.84	50.75	4.56	5.10	13.76	46.70	307.47	12.61	260.77
V_3: Phule Pandhari	37.61	37.74	4.03	3.68	12.45	41.17	307.99	12.99	262.99
F test	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	N.S.	N.S.	N.S.
SEm +	1.16	1.06	0.090	0.13	0.43	1.87	1.59	0.35	1.32
CD at 5%	3.43	3.13	0.26	0.39	1.28	5.51	–	–	–
Interaction effect									
F test	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
SEm +	2.60	2.37	0.20	0.30	0.97	4.17	3.57	0.79	2.97
CD at 5%	–	–	–	–	–	–	–	–	–
General mean	38.40	42.01	4.05	4.16	12.44	40.91	307.96	13.01	263.16

Effect of cowpea varieties

Maximum and significantly higher uptake of N, P and K in grain, stover and their total was observed in Konkan Safed followed by Phule Pandhari and Konkan Sadabahar. Since, uptake of nutrients in cowpea is a function of grain and stover yield and their nutrient content, the improvement in the content of these nutrients coupled with significantly increased grain and stover yield increased the uptake of nutrients. The results resemble the findings of Patil *et al.*, (1991).

The available N, P_2O_5 and K_2O content of soil after harvest of cowpea varieties were not influenced significantly. There was in general, more or less improvement in available status of N and P_2O_5 nutrients under all the varieties after harvest over their initial levels, indicating the overall improvement in soil fertility after harvest of cowpea varieties. However, there was little reduction in available K_2O status compared to its initial level under all varieties as it was not supplied through inorganic fertilizer.

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Evaluation of Maize Hybrids for Salt Tolerance due to Saline Irrigations through Drip in Andhra Pradesh

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A field experiment was conducted with three maize hybrids *viz*, Sandhya, 30V92 and DHM-117 treated with four levels of irrigations *viz*., BAW (Best Available Water), 2.0 dSm^{-1}, 4.0 dSm^{-1}, 6.0 dSm^{-1} through drip irrigations in Factorial Randomized Block Design with three replications. Significant yield reductions were noticed in all the three maize hybrids when irrigated with saline waters. It was found that 30V92 hybrid produced the highest yield (6008 kg ha^{-1}) among hybrids. The soil physico-chemical properties and nutrient contents were also studied to know the impact of saline irrigation. Considerable variations were observed in soil properties also. It was found that soil pH was decreased with increase in soil EC levels. The N, P, K nutrient contents in soil were decreased with higher EC levels due to non availability of water. Highest K/Na ratio was found in 30V92 hybrid and it reveals that it is tolerant to salinity levels when compared to other hybrids.

(Key words: *Saline drip irrigations, Maize hybrids, Yield, Soil properties, Saline tolerance)*

The rapid increase in the world population demands an expansion of crop areas to raise food production. In this context, a significant fraction of agricultural crops are cultivated on low quality soils, sometimes affected by salinity. It is well known that salinity is a common stress factor in agricultural areas as a result of extensive irrigation with saline water and fertilizer application (Mc Kersie and Leshem, 1994). In addition to that fresh water scarcity ranks first among the most urgent challenges of this century. Now-a-days the competition for fresh water in the development of urbanization, industry and agriculture causes the decline of fresh water for irrigation (Qadir and Oster, 2004). Salinity is a major stress which decreases crop growth and productivity and it is a serious problem for agriculture and consequently the development of salinity tolerant hybrids/varieties is considered an important research subject (Munns, 2009).

Drip irrigation, with its characteristic of low rate and high frequent irrigation applications over a long period of time, can maintain high soil matric potential in the root zone thus compensate the decrease of osmotic potential introduced by the saline water irrigation and the constant high total water potential can be maintained for the crop growth. Therefore drip irrigation has been regarded as the most advantageous method for applying saline water to crops (Kang, 1998).

Maize (*Zea mays* L.) is classified as moderately sensitive to salinity (Mass and Grattan, 1999) and one of the major crops grown in Andhra Pradesh, India. Andhra Pradesh occupies 5th rank in area (0.79 mha) with 20.9% of total maize production (4.14 mt) and productivity (5.26 t ha^{-1}) in the country. During recent years, in Andhra Pradesh especially Krishna Western Delta area maize crop cultivated area has been increased from 3.9 lakh ha (1998) to 4.9 lakh ha (2011) but the productivity decreased from 3.8 tha^{-1} to 3.4 tha^{-1} due to saline irrigation water. Moreover, most of maize cultivated lands are located in areas where saline irrigation water is the primary water source. Hence there is a need to find out the best yields in salinity conditions for this crop. Therefore identifying salt tolerant hybrids is critically important for a particular area. So, an attempt was made with two objectives of, (i) to investigate the effects of drip irrigation with saline water of different salinity levels on yield and (ii) to assess the soil salinity under drip irrigation with saline water of different salinity levels. Keeping in view all the above discussion, an experiment was conducted using three maize hybrids at four levels of salinity BAW (Best available water), 2.0, 4.0 and 6.0 dSm^{-1}) to find out the salt tolerant maize hybrid that could be further used to evaluate its potential with natural saline water.

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MATERIALS AND METHODS

Experimental site and Analytical methods

The field experiment was laid out at Saline Water Scheme, Bapatla, Andhra Pradesh state, India during the *Rabi* seasons of 2009-2012. The experimental design was Factorial Randomized Block Design having three maize hybrids viz., Sandhya, DHM-117 and 30V92 tested under four water qualities viz. BAW, 2.0, 4.0 and 6.0 dSm^{-1}. The maize hybrids used in this study were tested for salinity tolerance under different water qualities in our experiment. Each plot was 4.2 x 6 m in area and the position and location of plots was the same during the three years of experiment. The system consisted of a tank and 6 drip lines per plot were arranged. For every 20cm distance the openings of each drip line was distributed to supply of water. The tank was installed at 1m above the ground to contain irrigation water. Phosphorus and Potassium were applied basally at the rate of 24 kg ha^{-1} and 20 kg ha^{-1} respectively. Nitrogen was applied at the rate of 96 kg ha^{-1}. Half of N was applied at sowing and the remaining half was applied with 2nd irrigation. The initial soil samples were analyzed and found that the soil was in slightly alkaline in reaction (8.11), Electrical Conductivity was normal (0.47dSm^{-1}), sodium was the dominant cation 38.59 meq l^{-1} and bicarbonate anion 3.72 meq l^{-1} and available nitrogen 211 kg ha^{-1}, available Phosphorus was 29 kg ha^{-1} and available potassium was 452 kg ha^{-1} (Table 1). Soil EC, pH, cations & anions were analyzed by standard procedures given by Tandon (2006).

Seeds of three maize hybrids viz. Sandhya, 30V92 and DHM 117 were sown during *Rabi* seasons of three years of 2009-2012. Before sowing three maize hybrid seeds were treated with best available water, 2, 4, and 6 dSm^{-1} levels of water. Germination was affected by 40% at 8 dSm^{-1}. Based on those results we have taken only up to 6 dSm^{-1} irrigation treatment. Total grain yield was also weighed during the harvest. The obtained data were statistically analyzed by following the methods of Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Precipitation received during crop period of *Rabi* season was 352.7 mm in 2010 year, 157.8 mm in 2011 and 335.2 mm in 2012 (Fig.1). The highest precipitation was recorded during the year 2010-11 when compared to other years. There were two effective annual precipitation events occurred during January, 2012 (111.5mm in 2 days) and February, 2013 (69.4 mm in one day).

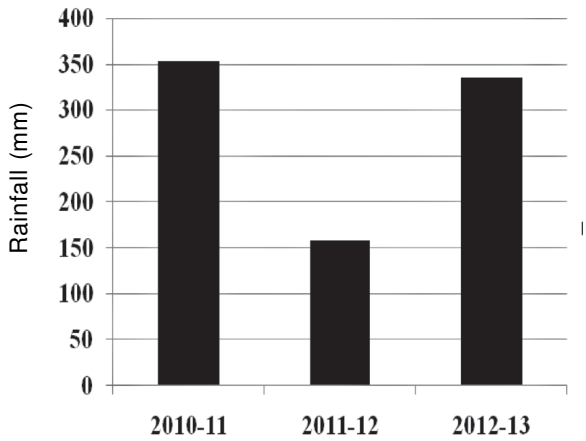

Fig. 1. Rainfall received during the crop period (*Rabi* season)

Maize Grain Yield

The results shown in table 2 revealed that increasing water salinity drastically decreased yield and reached minimum (5293 kg ha^{-1}) at 6 EC dSm^{-1} irrigation. The highest grain yields of 8508 kg ha^{-1} and 8806 kg ha^{-1} were obtained with best available water treatment in 2010-11 & 2011-12 years respectively. The overall (pooled data of three years data) results of maize hybrids showed that 30V92 hybrid produced more grain yield (6008 kg ha^{-1}) and performed best among the hybrids. The significant decrease of yield was recorded with increasing the EC level of irrigation water irrespective of hybrid type. The interaction between hybrids and different levels of irrigation water was non significant in two years and significant in one year (2011-12). But the interaction effect was significant in pooled data. Hence 30V92 hybrid had shown highest yield showed even in higher EC levels also. The results for this important trait agree with the findings of

Table1. *Initial soil analysis of experimental field*

pH	EC (dSm^{-1})	$CO_3^{=}$	HCO_3^{-}	Cl^{-}	$SO_4^{=}$	Ca^{+2}	Mg^{+2}	Na^{+}	K^{+}	Avail N	Avail P_2O_5	Avail K_2O
		meqL^{-1}								kg ha^{-1}		
8.11	0.47	0.0	3.72	1.80	0.23	2.80	2.80	38.59	0.16	211	29	452

Kang *et al.*, (2010) who have concluded that the yield decreased as the salinity of irrigation water increased. There is a negative linear relationship between relative yield and salinity of irrigation water. Pasternak *et al.*, (1995) working on screening of maize cultivars under application of brackish water reported that early flowering cultivars were more salt tolerant than late flowering cultivars and major factor associated with salinity tolerance was genetic potentiality of the genotype. Gandahi *et al.*, (2009) also reported that maize yields were decreased with increasing EC levels of irrigation and high salt concentration in maize root zone decreased soil water availability and crop produced low yields.

Table 2. *Yield data of Maize crop at different EC Levels (Year wise)*

Treatments	Yield (kg ha^{-1})			
	2010-11	2011-12	2012-13	Pooled
Hybrids				
30V92	7571	7617	5663	6008
Sandhya	8183	6574	5132	5208
DHM117	6778	5338	4808	5201
SEm+	291	175	119	116
CD(0.05)	853	514	346	163
EC Levels				
BAW	8508	8806	7008	8008
2EC	8245	6683	5862	6930
4EC	6829	5815	4933	5859
6EC	6458	5034	4385	5293
SEm+	336	152	154	211
CD(0.05)	985	445	447	432
Interaction				
SEm+	582	304	267	365
CD(0.05)	NS	1051	NS	748

Effect of saline irrigation water on soil Chemical Properties of soil

Soil chemical properties showed remarkable changes to irrigation water qualities and magnitude of reduction in values of soil properties depended on water quality. The harmful effects were mainly associated with accumulation of salts in the soil profile where slow growth rate in plants was observed (CSSRI, 1998). The results on soil chemical properties are as under.

Soil pH

Soil pH is the most important parameter which shows the overall changes in soil chemical properties. The analysis of soil showed that pH values decreased as a salinity level of irrigation water increased (Table 3). The maximum value of pH (7.39) was recorded under best available water treatment while minimum pH (6.94) was noted at higher levels of saline water (EC 6 dSm^{-1}). This may be due to the fact that H^+ ions are released from the exchange complex by the influence of other soluble cations in the applied saline water (Mahrous *et al.*, 1983) or due to increasing the solubility of $CaSO_4$ and sulfate transformation which led to decrease in the soil pH values.

Soil Electrical Conductivity

Soil electrical conductivity significantly increased as a result of increasing salinity levels of irrigation water (Table 3). Pooled data of all three years observed that maximum EC (1.15 dSm^{-1}) was recorded in the plots which treated with EC 6 dSm^{-1} irrespective of hybrids and minimum was recorded under application of best available water (0.35 dSm^{-1}). Similarly, interaction between water qualities and maize hybrids also showed significant increase. There were two heavy rainfall events occurred during January, 2012 (111.5 mm in 2 days) and February, 2013 (69.4 mm in one day) so that's why the soil EC values are not that much increased with increasing saline irrigations due to dilution effect of salts by rain water. These results are in agreement with the findings of Ragab (2001) that there was a progressive and significant increase in soil salinity

Table 3. *Effect of saline irrigation water on soil properties*

Treatments	Soil properties (mean of three years)				
	pH	EC	N (kg ha^{-1})	P_2O_5 (kg ha^{-1})	K_2O (kg ha^{-1})
Hybrids					
30V92	7.23	0.78	207	28.7	449
Sandhya	7.10	0.61	202	31.8	434
DHM117	7.19	0.72	202	31.6	429
SEm+	0.061	0.01	2.4	0.52	2.9
CD(0.05)	NS	0.045	NS	1.51	8.44
EC Levels					
BAW	7.39	0.35	218	33.7	457
2EC	7.24	0.67	208	30.8	446
4EC	7.11	0.85	200	29.3	432
6EC	6.94	1.15	189	28.9	414
SEm+	0.07	0.018	2.8	0.60	3.3
CD(0.05)	0.205	0.052	8.26	1.75	9.74
Interaction					
SEm+	0.121	0.031	4.9	1.04	5.8
CD(0.05)	NS	0.107	NS	NS	NS

with increase in saline irrigation water. Gupta (1990) reported that highly saline water with an EC of 6 dSm^{-1} leads to a considerable increase in soil salinity even over a short period of growth and saline water with an EC of 4 dSm^{-1} could be utilized without much reduction if the salinity of soil is well maintained.

Soil available Nitrogen

Soil available nitrogen was significantly decreased with increasing EC levels of irrigation water while the interaction effect was not significant. The lowest Nitrogen content (189 kg ha^{-1}) was obtained with 6 dSm^{-1} EC level of irrigation (Table 3). The highest Nitrogen content was observed in 30V92 hybrid compared to others. These findings suggest that the reduced water availability to plants under salinity might prevent the availability of nutrient elements also. Mashali *et al.*, 2009 reported that soil content of available N decreased with increasing salinity levels or Na concentration in irrigation water used. Same findings were noted with Kumawat *et al.*, (2011).

Soil available Phosphorus

Saline irrigation water significantly decreased the soil available P_2O_5 (Table.3). Results were supported by Kumawat *et al.*, (2011) who reported that increasing level of EC of irrigation water decreased the available NPK and organic carbon of soil but increased the salinity of the soil. The results were agreed with Zahoor *et al.*, (2011) by indicating the phosphorus status in soil.

Soil available Potassium

Increasing salinity levels of irrigation has reduced the availability of soil potassium contents (Table 3). Potassium is an essential element for plant survival in saline habitats. It contributes in osmotic adjustment and overall water balance to plants. Whenever saline irrigation water enters into soil system the water availability decreases and Na^+ concentration increases instead of K^+ and it leads to lower availability of K nutrient to plant. Our experimental results were also correlated with Akram *et al.*, (2010).

Plant Potassium and Sodium contents

The plant samples were collected at harvest and analyzed for K and Na concentrations. In this study the Na accumulation in the plant samples followed the trend of DHM 117 > Sandhya > 30V92 hybrids while K accumulation followed the reverse trend. The high salt concentration competes with the other nutrient concentrations, especially K and leading to K deficiency. High salt induces increase in the Na and decrease in K in plants. Highest K and lowest Na accumulation was observed in 30V92 hybrid could be due to it's adaptive character towards saline environment. Salt tolerance has been associated with higher K and lower Na. It supports that 30V92 has the ability to some extent the salt tolerance character compared to other hybrids. Automatically, K/Na ratio was also found more in 30V92 hybrid only (Fig. 2 & 3). The results were coincided with Muhammad Akram *et al.*, (2010).

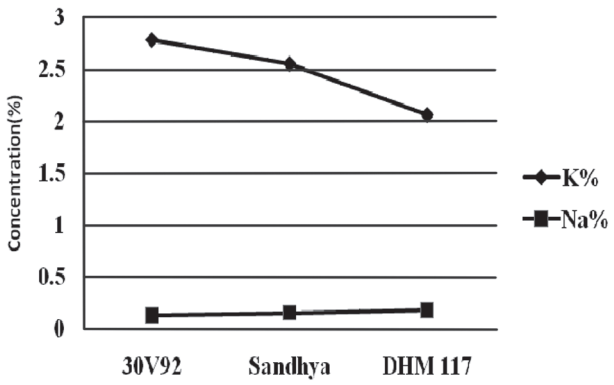

Fig. 2. K% and Na% in plant at harvest

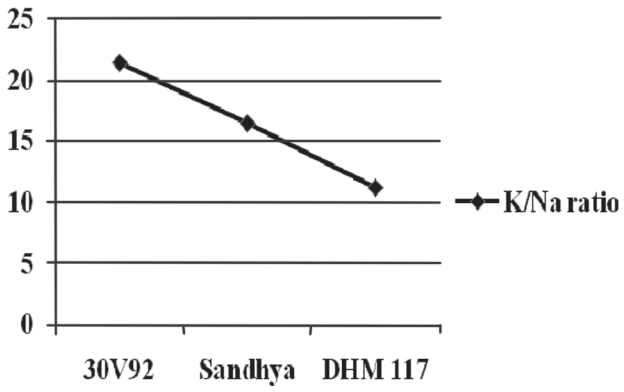

Fig. 3. K/Na ratio among hybrids

CONCLUSION

Present study revealed that among three maize hybrids, 30V92 hybrid showed good yields compared to other hybrids even in higher saline irrigations and in addition to that comparatively higher K/Na ratio was found in the same hybrid which resembles the salt tolerance character. The soil properties and nutrient availability also varied with increasing saline irrigations. Highest K and lowest Na concentrations in plant sample was found in 30V92 hybrid. By comparing all the three years data, 30V92 hybrid had shown its potentiality in bringing highest yield even in higher levels of saline irrigation water.

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Orthotropic Shoot Propagation in Black Pepper (*Piper nigrum* L.)

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An experiment on orthotropic shoot propagation in black pepper (*Piper nigrum L.*) was conducted at All India Co-ordinated Research Project on Spices, Dapoli centre during the years 2008-2009, 2009-10 and 2010-11. Twelve treatment combinations of three types of cuttings (2, 3 and 5 nodes) and four growth regulators IBA, PGPR (*Pseudomonas fluorescence* -10^8), 2% common sugar and control (without any treatment) were evaluated. Significantly maximum rooting success (89.11%) was observed in three node cuttings which were at par with two node cuttings (86.88%). Also significantly maximum rooting success (90.22%) was observed in PGPR treatment which was followed by common sugar (85.63%) treatment. The combined effect of types of cuttings and growth regulators indicate significantly maximum rooting success in two node cutting with PGPR treatment (97.32%) followed by three node cutting with PGPR (96.44%) and two node cutting with common sugar (90.21%) treatments. Economics of production of 1000 sellable black pepper cuttings showed highest net profit with two node cuttings with PGPR (Rs.3557) and common sugar 2% (Rs. 3442) followed by 3 node cuttings with PGPR (Rs. 2853) and common sugar 2% (Rs. 2611) treatment. For obtaining higher success in black pepper propagation from orthotropic shoots it is recommended to use two node cuttings (without leaves) treated with *Pseudomonas fluorescence*-10^8 powder formulation or dipped in common sugar 2% solution for one minute.

(Key words: *Orthotropic shoot, PGPR (Pseudomonas fluorescence -10^8), Common sugar solution)*

Black Pepper (*Piper nigrum L.*) is an important commercial spice crop of India and is a perennial climber, which can grow to a considerable height. Black pepper has two types of branches, namely orthotropic branches and plagiotropic branches. Orthotropic branches are straight, with upward growing growth habit, at each node, there may be 10-15 short adventitious clinging roots which adhere to support while climbing. At the axil of each leaf of orthotropic branches there is an axillary bud which develops into plagiotropic branches. The plagiotropic branches are laterally growing and produce flowers and fruits. Runner shoots are produced from the basal portion of main stem, growing at right angle to the main stem (Kumar *et al.*, 2006).

The runner shoots are generally used for propagation in black pepper, which have pre bearing age of 3-4 years. If orthotropic shoots are used as propagation material, the bearing i.e. flowering and fruiting is observed in the second year of planting and initial height of standard is effectively used for higher yield in black pepper in plantation crops like areca nut and coconut when propagated through orthotropic shoot. Hence the present investigation was conducted with a view to obtain more success to orthotropic shoot cuttings in black pepper by use of different growth regulators.

MATERIALS AND METHODS

The propagation experiment was carried out for three consecutive years (2008-09, 2009-10 and 2010-11) at the Deptt. of Horticulture, College of Agriculture Dapoli, Dist- Ratnagiri (MS) with twelve treatment combinations replicated thrice. Three types of cutting i.e. two node (N_1), three node (N_2) and five node (N_3) without leaves and, four rooting hormones *i.e.* common sugar 2% (H_1), IBA commercial formulation (H_2), PGPR *Pseudomonas fluorescens*-10^8(H_3) and control - without hormone (H_0) were used for the experiment. Twenty five cuttings per treatment were used as per treatment combinations for Panniyur-1 variety of black pepper. Four types of hormone treatments were used for cuttings viz. dipping of distil end of cuttings in IBA powder formulation, dipping of distil end of cuttings in PGPR (*Pseudomonas fluorescence* -10^8) powder formulation, dipping of cuttings in 2% common sugar solution for one minute and control without any hormonal treatment. Then cuttings were planted in poly bags containing standard potting mixture under poly shade. The irrigation, plant protection and after care followed as per requirement. The percent success of cutting was observed and recorded. The results were analyzed in factorial randomized block design as suggested by Panse and Sukhatme (1995).

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RESULTS AND DISCUSSION

The mean rooting success of orthotropic shoots of black pepper as affected by number of nodes of cutting, rooting hormone and their interactions in different years are presented in Table 1 to 4.

Effect of nodes

The pooled mean rooting success of orthotropic shoots of black pepper as affected by number of nodes of black pepper cuttings are presented in Table 1.

It was observed from results presented in Table 1 that there was significant difference in rooting success of black pepper among different nodes of cuttings. It was observed that three node cuttings of black pepper gave significantly maximum rooting success which was as high as 89.11% and at par with two node cutting of black pepper (86.88%). The significantly low rooting success was observed in treatment five node cutting i.e. 72.78%. Results analogous to these findings were also recorded in rapid multiplication of black pepper on soil mound & bamboo splits using runner shoots of black pepper by Khandekar *et al.,* (2004).

Effect of hormones

The mean pooled rooting success of orthotropic shoots of black pepper as affected by different hormones treatments are presented in Table 2. It was observed from results presented in Table 2 that there was significant difference in rooting success of black pepper among different hormone treatments. It was observed that plant growth promoting hormone (PGPR) treatment gave significantly maximum rooting success which was as high as 90.22%, and at par with common sugar 2% treatment (85.63%). The significantly low rooting success was observed in control treatment i.e. black pepper cuttings without hormone (75.41%).

Interactions effect of node of cutting and hormone

The pooled mean interaction effects of number of nodes of cuttings and rooting hormone on rooting success of orthotropic black pepper cuttings are presented in Table 3. It was observed from the results presented in Table 3 that interaction effect of no. of node of cuttings and rooting hormone treatment was found to be significant on rooting success of orthotropic black pepper cuttings. The data regarding interaction effect (Table 3) indicate that significantly maximum rooting success was observed in treatment N_1H_3 i.e. two node cuttings with PGPR treatment as high as 97.32% which was followed by three node cutting with PGPR treatment (N_2H_3) and two node cuttings with common sugar 2% treatment (N_1H_1), 96.44% and 90.21%, respectively.

Table 1: *Effect of number of node of cutting on rooting success of black pepper*

Sr. No.	Treatment	Mean rooting success (%)			Pooled
		2008-09	2009-10	2010-11	
1	N_1 (Two Node cutting)	72.33 (59.59)*	94.32 (78.63)	93.99 (77.75)	86.88 (71.99)
2	N_2 (Three Node cutting)	79.99 (66.75)	94.00 (76.10)	93.31 (75.38)	89.11 (72.74)
3	N_3 (Five Node cutting)	70.00 (56.90)	74.67 (59.95)	73.67 (59.26)	72.78 (58.70)
	SEm +	2.00	0.89	0.85	2.67
	CD at 5%	5.85	2.60	2.49	10.47

* Fig. in parenthesis are arcsine transformation

Table 2*: Effect of rooting hormone on rooting success of black pepper*

Sr. No.	Treatment	Mean rooting success (%)			Pooled
		2008-09	2009-10	2010-11	
1	Common Sugar 2% (H_1)	73.33 (58.98)*	92.44 (76.47)	91.11 (74.42)	85.63 (80.84)
2	IBA (H_2)	71.55 (59.33)	85.33 (68.66)	84.44 (67.96)	80.44 (76.37)
3	PGPR (H_3)	89.77 (74.12)	90.66 (75.19)	90.22 (74.88)	90.22 (85.00)
4	Without hormone (H_0)	61.78 (51.90)	82.22 (65.92)	82.22 (65.93)	75.41 (72.11)
	SEm +	2.30	1.02	0.98	2.43
	CD at 5%	6.76	3.00	2.88	8.40

*Fig. in parenthesis are arcsine transformation

Table 3 : *Effect of interaction of no. of node of cutting & rooting hormone on rooting success of black pepper*

Sr. No.	Treatment	Success (%)			Pooled
		2008-09	2009-10	2010-11	
1	N_1 H_0	56.00 (48.48)*	88.00 (69.91)	89.33 (71.19)	77.78 (63.19)
2	N_1 H_1	74.67 (59.85)	98.65 (85.52)	97.32 (81.99)	90.21 (75.78)
3	N_1 H_2	64.00 (53.21)	92.00 (73.57)	90.67 (72.29)	82.22 (66.36)
4	N_1 H_3	94.67 (76.83)	98.65 (85.52)	98.65 (85.52)	97.32 (82.62)
5	N_2 H_0	66.67 (54.85)	90.67 (72.29)	89.33 (71.01)	82.22 (66.05)
6	N_2 H_1	74.67 (59.88)	96.00 (78.46)	94.67 (76.83)	88.44 (71.73)
7	N_2 H_2	81.32 (68.38)	93.33 (75.20)	93.33 (75.20)	89.33 (72.93)
8	N_2 H_3	97.31 (83.88)	96.00 (78.46)	96.00 (78.46)	96.44 (80.27)
9	N_3 H_0	62.67 (52.36)	68.00 (55.55)	68.00 (55.58)	66.22 (54.50)
10	N_3 H_1	70.67 (57.22)	82.67 (65.43)	81.33 (64.43)	78.22 (62.36)
11	N_3 H_2	69.33 (56.38)	70.67 (57.22)	69.33 (56.38)	69.78 (56.66)
12	N_3 H_3	77.33 (61.64)	77.33 (61.59)	76.00 (60.67)	76.89 (61.33)
	Mean	74.11 (61.08)	87.66 (71.56)	87.00 (70.80)	82.92 (67.81)
	SEm +	3.99	1.77	1.70	3.26
	CD at 5%	11.70	5.19	4.98	9.57

*Fig. in parenthesis are arcsine transformation

Table 4 : *Cost of production of 1000 sellable black pepper plants by orthotropic shoots (cost in Rs., 2010-11)*

Sr. No.	Particulars	Black pepper orthotropic shoots				
		Without hormones (Rs)	PGPR treatment (Rs)		Common sugar treatment (Rs)	
		2 nodes cutting	2 nodes cutting	3 nodes cutting	2 nodes cutting	3 nodes cutting
1	Material cost	3440	1950	2450	2050	2550
2	Labour cost	1600	1200	1320	1200	1440
3	Other cost	524	293	377	308	399
4	Total cost	5564	3443	4147	3558	4389
5	Net return by selling of produce	7000	7000	7000	7000	7000
6	B:C ratio	1.26	2.03	1.69	1.97	1.59
7	Net profit per 1000 sellable cuttings	1436	3557	2853	3442	2611

The significantly low rooting success was observed in N_3 H_0 (five node cuttings without hormone treatment) as low as 66.22% which was at par with N_3H_2 (69.78%), N_3H_3 (76.89%) and N_1 H_0 (77.78%), respectively. Higher success in black pepper propagation from orthotropic shoots with *Pseudomonas fluorescens* and common sugar treatment could be attributed to early establishment, better root growth which was responsible for higher success in black pepper 2 and 3 node orthotropic shoot cuttings. (Hartmann *et al.*, 2002).

The economics of production of 1000 sellable black pepper cuttings are presented in Table 4. It was observed that highest net profit was observed with two node cuttings with PGPR (*Pseudomonas fluorescence* -10^8) treatment (Rs. 3557) and common sugar 2% treatment (Rs. 3442) followed by 3 node cuttings with PGPR treatment (Rs. 2853) and common sugar 2% treatment (Rs. 2611). For obtaining higher success in black pepper propagation from orthotropic shoots it is recommended to treat two node cuttings (without leaves) with *Pseudomonas fluorescence*-10^8 powder

formulation or dipped in common sugar 2% solution for one minute.

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Palmyrah Palm (*Borassus flabellifer* L.) Diversity in North Konkan Coastal Region of Maharashtra

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Palmyrah (*Borassus flabellifer* L.) is still underutilized important palm in the north Konkan region of Maharashtra. Out of total area in Maharashtra, around 90 per cent area is in only Thane district. Each part of this palm is commercially exploited. It is dioecious palm and there is wide diversity. The survey was carried out during the years 2008 to 2010 in Thane district of Maharashtra state to study the diversity of palms with special reference to sex determination and to collect the elite types of palmyrah having peculiar characteristics. From the surveyed palms the male : female ratio was 1 : 1.46. The palms having peculiar characteristics like high potential of Toddy tapping, nut and kernels quality, growth performance were also identified and selected for further evaluation.

(Key words : *Palmyrah (Borassus flabellifer L.), Dioecious palm, Male : Female ratio, Toddy tapping, Kernels quality****)***

Palmyrah (*Borassus flabellifer* L.) is a tropical palm. In India, it occurs in Tamil Nadu, Andhra Pradesh, Odisha, West Bengal, Bihar, Karnataka and Maharashtra. It is a multipurpose tree and is exploited for food from the fruit and tuberous seedlings, beverage and sugar from the sap, fiber from the fruits and leaves for brushes, cordage weaving and plaiting, and trunk wood for construction and fuel. Due to its multifarious uses, the Government of Tamil Nadu has declared it as a 'state tree' (Sankaralingam *et al.*, 1999). It is one of the most important palm in the north Konkan region of Maharashtra. In Maharashtra out of total acerage, 90 per cent area under Palmyrah is in Thane district only. This palm is found in a belt of Dahanu, Palghar, Vasai (Near seashore) tahasils of Thane district and some part of Raigad district and middle track of north Konkan region. Palmyrah is a dioecious palm with the great majority of its economic products such as immature endosperm, mesocarp pulp, tuberous seedlings obtained only from female palms. But sweet sap from the inflorescence, toddy, palm sugar, brush fibre and wood are obtained irrespective of sex forms of palm.

However, differences in their yield or quality have been reported. Thus female palms are supposed to yield more toddy on tapping from the inflorescence (Davis *et al.*, 1987) and the female tree gives better and hard timber than the male tree, and is also more expensive (Kalarani *et al.*, 1991). As this palm is underutilized crop, there is no systematic plantation but the occurrence is scattered. It has unique importance in the economy of the farmers in the district. The farmers approach towards the management of Palmyrah palm is increasing day by day because now a days it has become economically important crop. Every part of the palm is utilized like coconut. The fresh fruits as well as Toddy of Palmyrah palm of Thane are very famous in Mumbai and adjoining areas. The kernel of young nut is hollow, soft as jelly, and translucent like ice, and is accompanied by a watery liquid, sweetish and potable, which has a great demand in Mumbai and nearby markets.

In north Konkan region of Maharashtra, the maximum cultivation is on the bunds of the rice field and barren lands and, the palms have been established since last century (more than 80 to 100 years old). Most of the palms are vigorous with high productivity in terms of toddy recovery and nut recovery. Due to improper management practices as the farmers are unknown regarding scientific management practices like manuring, irrigation, plant protection, etc. it remained as unexploited palm.

The palms are slow-growing perennials and have no distinguishing features to identify the sex until flowering. The palm commences flowering only after 12 to 15 years of maturity. On account of the dioecious nature and long juvenile period, farmers have hesitated in planting this multipurpose tree. Breeding and crop improvement would be highly

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Table 1 (A). *Occurrence of male and female Palmyrah palm (Year 2008-09)*

Sr. No.	Location	Male palms	Female palms	Remarks
1.	Kelwa (Revale)	27	39	11*
2.	Vadrai (Sea shore)	21	43	29*
3.	Sarawali (Boisar)	18	28	14*
4.	Kolgaon	9	9	3*
5.	Shri. Anand Balaram Raut, Vadrai	7	18	5*
6.	Nilakant Raut, Haranwadi	3	7	5*
7.	Shri. Vinod More, Dhansar	6	5	3*
	Total	**91**	**149**	**70***

(*Juvenile and not started flowering), Male : Female Ratio = 1 : 1.64

facilitated if gender could be determined at the seedling stage itself. This would help farmers while selecting the seedlings and maintain an optimum sex ratio at plantation.

To overcome the above problems a systematic research work on Palmyrah with multidiscipline approach has been initiated at Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli. In this context, the survey was carried out in Thane district of Maharashtra state to study the diversity of palms with special reference to sex determination and to collect the elite types of palmyrah having peculiar characteristics.

MATERIALS AND METHODS

The survey was carried out in coastal tahasils of the Thane districts during 2008 to 2010. For survey work palm pockets were randomly selected and male, female palms were recorded. In the year 2008-09, 310 palms were surveyed and in the year 2009-10, 177 palms were surveyed. The fruiting behaviour i.e. No. of nuts per spadix, male female ratio, no. of kernels per nut were also observed and palms those have peculiar characteristics were recorded.

Table 1 (B). *Occurrence of male and female Palmyrah palm (Year 2009-10)*

Sr. No.	Location	Male palms	Female palms	Remarks
1.	Kurgaon (Palghar)	14	11	7*
2.	Chinchani (Dahanu)	8	8	5*
3.	Chikhala (Dahanu)	14	20	12*
4.	Dapoli (Palghar)	21	34	23*
	Total	**57**	**73**	**47***

(* Juvenile and not started flowering), Male : Female Ratio = 1 : 1.28

Table 2. *Identified types having peculiar characterstics*

Sr. No.	Name of farmer	Village	No. of identified types	Peculiarity
I)	(Year 2009-10)			
1.	Shri. Vinod More	Dhansar	2	High yield of Toddy (25 litres day^{-1})
2.	Shri. Anand Raut	Vadrai	7	Heavy bearing, more than 3 kernels per nut, large size, regular bearing.
3.	Shri. Hareshwar Patil	Kolgaon	1	Heavy bearing and more than 3 kernels per nut.
4.	Not owned by any farmer	Road side in Mahim, Mahim Palghar road	1	Heavy bearing (50 to 70 nuts spadix^{-1} and 8 -12 spadix per palm)
5.	Not owned by any farmer	Seashore of Vadrai	3	Heavy bearing, large size nuts
6.	Shri. Navaneet D. Mali	Satpati	2	High yield of Toddy
7.	PWD	Gathanipada, Palghar Boisar Road	2	Heavy bearing (200 nuts palm^{-1})
8.	PWD	Kelwa Mahim Raod	4	Heavy bearing
II)	(Year 2009-10)			
1.	Road side Palghar Bypass road	Palghar	1	Early and heavy bearing (compact) (might be a dwarf type)
2.	Kolgaon	Kolgaon	2	High yield of Toddy (21-25 litres day^{-1})

RESULTS AND DISCUSSION

It is revealed from the data presented in Table 1(A) that during the year 2008-09, out of 310 surveyed palms, 70 (22.58 per cent) palms were in juvenile phase where sex of palm was not identified, 149 (48.06 per cent) were female palms and 91 (29.35 per cent) were male palm. The male : female ratio was 1 : 1.64. During 2009-10 out of 177 surveyed palms, 47 (26.55 per cent) palms were in juvenile phase, 73 (41.24 per cent) were female palms and 57 (32.20 per cent) were male palms [Table 1(B)]. The male : female ratio was 1 : 1.28. The average male : female ratio was 1 : 1.46.

The palms having peculiar characteristics like high potential of toddy tapping, nut and kernels quality, growth performance were also reported and given in Table 2. In all 25 elite palmyrah palms were identified during the survey work of 2008-09 and 2009-10 (Table 2). The elite palms are distributed throughout coastal region of Thane district in villages viz; Dhansar, Vadrai, Kolgaon, Satpati, Gothanipada and Palghar. Peculiar characteristics in elite palms were more than three kernels per nut, high yield of toddy, more number of nuts per spadix, large size nuts, early bearing distributed among population.

The research work on the same line has been initiated. The promising germplasm types in palmyrah available in Andhra Pradesh and Tamil Nadu States were collected and a gene bank has been established (Anonymous 2007). Thus it is concluded that there is genetic diversity in palmyrah and has immense potential for commercial exploitation in north Konkan coastal region of Maharashtra.

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Polygenic Variation and Character Association in Panicle Characters of some Recombinant Inbred lines (RIL's) of Basmati Derivative in *Sunderbans* Area of West Bengal

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Fourteen recombinant inbred lines (RIL's) of progenies obtained from IR 30/Basmati 370 cross derivative were evaluated along with two popular varieties viz. Khitish (IET4094) and Minikit (IET 4786) for 16 biometrical characters during November 2011- March 2012 at Regional Research Station, Coastal Saline Zone, Bidhan Chandra Krishi Vishwavidyalaya, Kakdwip, South 24 Parganas, West Bengal, India. Except number of primary branches per panicle, fertility percentage, grain breadth, grain L/B ratio and kernel breadth all the characters studied showed significant differences among the genotypes. Six lines (S_{14}, S_{10}, S_1, S_2, S_3 and S_4) possessed significantly higher grain yield than superior check variety. High estimates of PCV and GCV were recorded for number of grains per panicle, florets number per panicle, number of panicle per plant, kernel length, kernel L/B ratio and panicle weight. High heritability was observed for 1000 grain weight, grain yield per plant, floret number per panicle, panicle length, number of panicle per plant, kernel length and kernel L/B ratio. High genetic advance was observed for florets number per panicle, number of grains per panicle, fertility % and number of panicle per plant. Genetic advance as percentage of mean was highest for floret number per panicle and it was lowest for grain breadth. High heritability coupled with high GA was recorded for floret number per panicle and number of grains per panicle. It indicated the predominance of additive gene action for controlling these characters. Therefore, these characters can be improved simply through selection. High heritability associated with low genetic advance was observed for panicle length, number of panicle per plant, 1000 grain weight, kernel length and kernel L/B ratio. It suggested non-additive gene action for the expressions of these characters. The magnitude of genotypic correlation coefficient was in general higher than that of the corresponding phenotypic ones. Grain yield per plant was significantly correlated with number of panicles per plant, number of primary branches per panicle and number of grains per panicle. Floret number per panicle imparted the highest positive direct effect on grain yield followed by kernel breadth and kernel L/B ratio.

***(Key words**: Recombinant inbred lines (RIL's), Basmati derivatives, Genetic advance, Heritability and path coefficient)*

Information on genetic variability, heritability and genetic advance are basics for tailoring an effective breeding programme. Correlation analysis figures out the intensity and direction of relationship between any two characters. Such information helps to ascertain the merits of individual character for the improvement of other associated and dependent character like Yield. The present study was, therefore, undertaken to study the genetic variability, heritable component of variation, correlation between yield and its contributing characters and the extent of magnitude and direction of association between yield and yield attributes among the RIL's of rice.

MATERIALS AND METHODS

The experiment was conducted during November 2011-March 2012 at Regional Research Station, Coastal Saline Zone, Bidhan Chandra Krishi Vishwavidyalaya, Kakdwip, South 24 Parganas, West Bengal, India. The experiment was laid out in Randomized Block Design with two replications. The experimental material comprised 14 recombinant inbred lines (RIL's) obtained from IR 30/Basmati 370 cross derivatives and two check varieties viz., Khitish (IET4094) and Minikit (IET 4786). Single seedling per hill was transplanted at a spacing of 20cm ×15cm in 5m×3m plot accommodating 500 hills in each of the 15 m^2 plots. The fertilizer dose followed

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was 80:40:40 N:P:K Kg ha^{-1} out of which 40:40:40 N:P:K Kg ha^{-1} applied as basal dose and remaining 40 Kg N were applied in two split dose one at tillering stage and another at panicle initiation stage. No plant protection measures had been followed since there is no insurgence of disease and insects. Seeds sowing and transplanting were done on 7th and 28th November, 2011. The observation on 16 characters viz., panicle weight (g), number of panicle per plant, panicle length (cm), number of primary branch per panicle, number of secondary branch per panicle, number of grain per panicle, floret number per panicle, fertility percentage, 1000 grain weight (g), grain length (mm), grain breadth (mm), grain L/B ratio, kernel length (mm), kernel breadth (mm), kernel L/B ratio and grain yield per plant (g) were recorded on five randomly selected plants from each entry. The mean data were used for statistical analysis following appropriate computer based statistical programme (Genres).

RESULTS AND DISCUSSION

The estimated mean performances for different traits of IR 30/ Basmati 370 cross derivative along with checks varieties are presented in Table 1. The number of panicle per plant ranged from 7.50 to 12.50. The maximum number of panicle per plant were recorded for S_1 and S_{10} (12.50) followed by S_{12} and S_{13} (11.00), S_4 (10.50) and S_7 (10.00) respectively while it was minimum for Khitish (7.50). S_{14}, S_{13}, S_{12}, S_{11}, S_9, S_{10}, S_6, S_7, S_4, S_2 and S_1 recorded more number of panicle per plant than the two check varieties and rest of the lines. The panicle weight was varied from 1.99g and 2.84g of which Khitish was the best performer (2.84) followed by Satabdi and S_8 (2.83), S_{14} (2.74) and S_2 (2.60) respectively and S_{13} (1.99) was poorest in this regard. The minimum value for panicle length was observed for S_{10} (24.50 cm) while S_5 (28.75) recorded longest panicle followed by S_4 (28.25), S_1 (28.00), S_6 (27.37), S_2 (27.05) and S_3 (26.12). S_{12}, S_{11}, S_9, S_8, S_7, S_6, S_5, S_4, S_3, S_2 and S_1 showed longer panicle than the two check varieties. The maximum number of primary branches per panicle was observed for Khitish i.e. 14.00 followed by S_{13} (13.00), S_1, S_4, S_{12} (12.25), S_2 and S_8 (12.00) respectively while the lowest value was observed for S_5 and S_7 (10.75). Satabdi (30.25) scored minimum value for number of secondary branches per panicle and Khitish (41.00) had maximum value followed by S_1 and S_{14} (35.50), S_8 (35.25), S_4 (34.00), S_3 and S_{11} (33.00) and S_2 and S_{12} (32.50) respectively. The maximum number of floret per panicle were recorded for S_1 (229.50) followed by S_{14} (225.25), S_2 (223.25), Satabdi (214.50) and Khitish (212.00) while S_9 (137.50) possessed lowest value in this regard. Only three lines S_1, S_2 and S_{14} showed superior performance over the check varieties in this regard. S_2 (200.25) registered maximum number of grains per panicle followed by Khitish (191.75), S_{14} (188.00) and S_3 (176.00) respectively while S_6 (124.25) registered minimum value for the same. A wide range of variation was observed for fertility percentage 71.30% (S_1) to 93.32% (S_4). S_4 was the top scorer (93.32) followed by S_{11} (92.27), Khitish (90.44) and S_3 (90.37), S_2 (89.67) and S_6 (89.07). Satabdi had lowest value for 1000 grain weight 17.47g while S_5 had highest 22.97 followed by S_4 (22.39), S_2 (22.03) and S_6 (21.32) respectively. The minimum grain length was observed for S_{12} (9.25mm) while maximum value 11.5 mm for S_6 and S_9 followed by S_{11} (11.35), S_4 (11.25) and S_2 (11.00) respectively. S_2, S_4, S_5, S_6, S_7, S_9 and S_{11} possessed longer grain than the two check varieties. S_8 showed at par grain length with Khitish while S_{13} with Satabdi. Grain breadth,one of the important features of rice that decides the market price possessed the less variation than the other characters. The range for grain breadth was observed from 2.30 mm (S_1, S_2, S_5,) to 2.60 mm (S_{11}). S_{11} possessed the maximum value 2.60 followed by Satabdi (2.55), S_{22}, S8, S_9, Khitish (2.50), S_{14} (2.45) S_4 and S_{13} (2.40) respectively. S_8 and S_9 showed at par grain breadth with Khitish. The highest value of grain L/B ratio was recorded for S_6 (4.61) followed by S_9 (4.59), S_4 (4.50) and S_2 (4.41) respectively while the lowest value was observed for S_{14} (3.87). The highest value for kernel length was found to be 9.2mm (S_6) followed by 9.00 (S_4 and S_{11}), 8.90 (S_9), 8.10 (S_2), 8.05 (S_5) while it was lowest for S_{12} (6.75mm). S_{11} (2.40) showed maximum kernel breadth followed by S_6, S_9, S_{14} (2.25), Satabdi (2.20), Khitish (2.15), S_{10} (2.10), S_1 (2.05) and the minimum kernel breadth was observed in S_2, S_3, S_4, S_5 (1.80). S_4 (4.54) ranked first for kernel L/B ratio followed by S_6 (4.09), S_2 (4.05) and S_5 (4.03) respectively. Grain yield per plant ranged from 18.11 g (Khitish) to 25.32g (S_{14}). Six lines (S_1, S_2, S_3, S_4, S_{10} and S_{14}) surpassed the check varieties in this regard.

The analysis of variance for 16 different characters presented in Table 2 revealed that all the characters except number of primary branches per panicle, fertility percentage, grain breadth, grain L/B ratio and kernel breadth had significant differences, indicating the presence of considerable genetic variability in the tested materials. The maximum range of variation was observed for floret number per panicle followed by number of grains

Table 1. *Mean performance of 14 RIL's of Basmati derivative along with check varieties for different characters*

Entry/ Genotype	Panicle plant^{-1} (no.)	Panicle weight (g)	Panicle length (cm)	Primary branches (no.)	Secondary branches (no.)	Florets panicle^{-1} (no.)	Grains panicle^{-1} (no.)	Fertility (%)	1000 grain weight (g)	Grain length (mm)	Grain breadth (mm)	Grain L/B ratio	Kernel length (mm)	Kernel breadth (mm)	kernel L/B ratio	Grain yield plant^{-1} (g)
1. S_1	12.50	2.19	28.00	12.25	35.50	229.50	161.00	71.30	18.82	9.75	2.30	3.94	7.00	2.05	3.41	23.54
2. S_2	9.50	2.60	27.05	12.00	32.75	223.25	200.25	89.67	22.03	11.00	2.30	4.41	8.10	2. 00	4.05	22.65
3. S_3	9.00	2.78	26.12	11.75	33.00	194.75	176.00	90.37	19.65	9.75	2.35	4.08	7.00	2.00	3.50	23.66
4. S_4	10.50	2.51	28.25	11.25	34.00	158.00	147.50	93.32	22.39	11.25	2.40	4.50	9.00	2.00	4.54	22.35
5. S_5	9.00	2.72	28.75	10.75	30.75	163.00	140.75	86.21	22.97	10.50	2.30	4.37	8.05	2.00	4.03	21.00
6. S_6	9.50	2.51	27.37	12.00	31.50	139.50	124.25	89.07	21.32	11.50	2.55	4.61	9.20	2.25	4.09	19.78
7. S_7	10.00	2.29	25.75	10.75	32.25	169.50	150.00	88.49	17.62	10.45	2.45	4.26	7.90	2.10	3.77	19.53
8. S_8	8.50	2.83	26.00	12.00	35.25	175.25	149.50	85.41	20.22	10.25	2.50	4.14	7.35	2.30	3.24	20.39
9. S_9	9.50	2.62	28.50	11.00	31.00	137.50	127.50	92.76	20.99	11.50	2.50	4.59	8.90	2.25	3.95	21.24
10. S_{10}	12.50	2.19	24.50	11.00	31.50	159.25	137.75	85.86	18.09	9.75	2.35	3.98	7.20	2.10	3.43	23.74
11. S_{11}	9.50	2.59	28.00	11.00	33.00	142.00	131.00	92.27	22.15	11.35	2.60	4.37	9.00	2.40	3.7	21.09
12. S_{12}	11.00	2.17	26.00	12.25	32.50	201.25	178.75	88.75	18.92	9.25	2.25	4.11	6.75	2.10	3.21	20.65
13. S_{13}	11.00	1.99	25.25	13.00	30.50	162.50	139.50	85.98	19.32	10.00	2.40	4.00	6.95	2.05	3.39	18.71
14. S_{14}	10.00	2.74	25.25	11.75	35.50	225.25	188.00	83.27	18.46	9.50	2.45	3.87	7.00	2.25	3.11	25.32
15. Khitish	7.50	2.84	28.25	14.00	41.00	212.00	191.75	90.44	20.69	10.25	2.50	4.01	7.40	2.15	3.44	18.11
16. Satabdi	9.00	2.83	25.25	11.25	30.25	214.50	171.75	80.37	17.47	10.00	2.55	3.91	7.20	2.20	3.27	21.80
Mean	9.90	2.52	26.76	11.75	33.14	181.68	157.20	87.10	20.07	10.37	2.42	4.20	7.75	2.13	3.63	21.47
LSD (0.05)	1.60	0.42	1.61	1.78	3.671	38.39	35.30	12.14	1.89	1.15	0.23	0.49	1.03	0.25	0.48	2.26

Table 2. *Variability and genetic parameters for different quantitative characters in RIL's of Basmati derivative*

Characters	Mean	Range	Variance			CV (%)	GCV (%)	PCV (%)	h^2 (BS)	GA	GA as % of mean
			Phenotypic	Genotypic	Environmental						
Panicle plant^{-1} (no.)	9.90	7.50 - 12.50	2.09	1.53	0.56	7.59	12.46	14.59	0.72	2.17	21.93
Panicle weight (g)	2.52	1.99 - 2.84	0.09	0.05	0.04	7.93	9.35	12.22	0.58	0.37	14.75
Panicle length (cm)	26.76	24.50 - 28.75	2.25	1.67	0.57	2.83	4.83	5.60	0.74	2.30	8.60
Primary branches (no.)	11.75	10.75 - 14.00	1.12	0.42	0.70	7.12	5.49	8.99	0.37	0.81	6.91
Secondary branches (no.)	33.14	30.25 - 41.00	8.85	5.88	2.96	5.19	7.31	8.97	0.66	4.07	12.29
Floret panicle^{-1} (no.)	181.68	137.50 - 229.50	1211.56	887.01	324.55	9.91	16.39	19.15	0.73	52.48	28.89
Grains panicle^{-1} (no.)	157.20	124.25 - 200.25	727.88	453.62	274.27	10.53	13.54	17.16	0.62	34.63	22.03
Fertility (%)	87.10	71.30 - 93.32	46.26	13.77	32.48	6.55	4.26	7.80	0.29	4.17	4.79
1000 grains weight (g)	20.07	17.47 - 22.97	3.57	2.78	0.78	4.42	8.31	9.41	0.77	3.03	15.12
Grain length (mm)	10.37	9.25 - 11.50	0.69	0.39	0.29	5.23	6.07	8.01	0.57	0.98	9.48
Grain breadth (mm)	2.42	2.30 - 2.60	0.02	0.01	0.01	4.52	2.99	5.44	0.30	0.08	3.38
Grain L/B ratio	4.20	3.87 - 4.61	0.08	0.03	0.05	5.48	4.41	7.03	0.39	0.23	5.71
Kernel length (mm)	7.75	6.75 - 9.20	0.85	0.62	0.24	6.28	10.11	11.90	0.72	1.37	17.70
Kernel breadth (mm)	2.13	2. 00 - 2.40	0.02	0.01	0.02	5.74	4.23	7.06	0.36	0.11	5.24
Kernel L/B ratio	3.63	3.11 - 4.54	0.19	0.14	0.05	6.28	10.20	11.98	0.72	0.64	17.88
Grain yield plant^{-1} (g)	21.47	18.11 - 25.32	4.50	3.37	1.13	4.95	8.54	9.87	0.74	3.26	15.23

CV: Coefficient of variation, GCV: Genotypic coefficient of variation, PCV: Phenotypic coefficient of variation, GA: Genetic Advance

per panicle, fertility percentage and number of secondary branches per panicle. Generally, the phenotypic variances were higher than the corresponding genotypic variances for all the characters. The highest estimates of phenotypic and genotypic variances were observed for florets number per panicle followed by number of grains per panicle and fertility percentage. The environmental influences in expression of some characters like 1000 grain weight, number of panicles per plant, panicle weight, panicle length, number of secondary branches, floret number per panicle, number of grain per panicle, grain length, kernel length, kernel L/B ratio and grain yield per plant were less as observed from the lower value of environmental variance the genotypic variance which implies that the environment has played not significant role in expression of these characters. The highest coefficient of variation was observed for number of grains per panicle followed by florets number per panicle, panicle weight, number of panicles per plant and number of primary branches per panicle where as it was lowest for 1000 grain weight. The magnitude of PCV was higher than the corresponding GCV for all the characters indicating the influence of environment in the expression of these characters (Dutta *et al.*, 2013; Kumar and Senapati, 2013). The high estimates of GCV and PCV were obtained for floret number per panicle, number of grains per panicle, number of panicle per plant, kernel length and kernel L/B ratio. In this regards, Sawant *et al.*, (1994) reported high GCV and PCV for grains per panicle, plant height, 1000 grain weight and grain yield per plant; Singh and Choudhary (1996) for number of panicles per plant, number of grains per panicle, grain yield per plant and 1000 grain weight; Nayak *et al.*, (2002) for number of panicles per plant, number of spikelets per panicle, number of grains per panicle and grain yield per plant; Sarkar *et al.*, (2005) for number of panicles per plant, number of tillers per plant and grain yield per plant; Panwar *et al.*, (2007) for straw yield per plant, grain yield per plant, total biological yield per plant, number of fertile florets per plant and number of branches per panicle; Raut *et al.*, (2009) for seed yield per plant, 1000 grain weight, grains per panicle and effective tillers per plant; Karthikeyan *et al.*, (2009) for straw yield per plant, grain yield per plant, total biological yield per plant, number of fertile florets per panicle and number of branches per panicle and Anjaneyulu *et al.*, (2010) for number of grain per panicle, fertility percentage and grain yield per plant.

High heritability was observed for 1000 grain weight, panicle length, grain yield per plant, kernel L/B ratio, kernel length, number of panicle per plant and floret number per panicle. These findings were in accordance with the reports made by Yadav *et al.,* (1992); Bihari *et al.*, (2004); Panwar *et al.*, (2007) and Karthikeyan *et al.*, (2009) for different characters. The lowest heritability was observed for fertility percentage. Genetic advance as percentage of mean was highest for florets number per panicle followed by number of grains per panicle and number of panicle per plant. These findings were corroborated by Karthikeyan *et al.*, (2009) for number of branches per panicle, straw yield per plant, total biological yield per plant and grain yield per plant; Sarma *et al.*, (1996) for effective tillers per m row length followed by panicle weight; Chaubey and Singh (1994) for grain yield per plant followed by panicle weight and total number of spikelets. The lowest GA as percentage of mean was observed for grain breadth.

High heritability coupled with high genetic advance was obtained for floret number per panicle and number of grains per panicle. These findings corroborated the reports of Singh *et al.,* (2005) for plant height; Sanker *et al.*, (2006) for days to 50% flowering, plant height, productive tiller per plant, panicle length, grain per panicle, 1000 seed weight and single plant yield; Singh *et al.*, (2007) for days to 50% flowering, grain per panicle and plant height; Kishore *et al.*, (2008) for days to 50% flowering, plant height; Anjaneyulu *et al.*, (2010) for number of grains per panicle, plant height and fertility percentage. It indicated the predominance of additive gene action for controlling these characters. Therefore, these characters can be improved simply through selection. High heritability associated with low genetic advance was observed for panicle length, number of panicle per plant, kernel length and kernel L/B ratio, kernel length, 1000 grain weight and grain yield per plant. It suggested non-additive gene action for the expressions of these characters. The high heritability was being exhibited due to favourable influence of environment rather than genotype therefore, direct selection for such traits might not be rewarding. Low heritability coupled with high genetic advance was registered for number of grain per panicle. It revealed that the character is governed by additive gene effects. The low heritability was being exhibited due to high environmental effects. Therefore, selection for this character might be effective. Low heritability coupled with low genetic advance was observed for panicle

Table 3. *Correlation coefficients for grain yield and quality traits in RIL's of Basmati derivative*

Characters		Panicle plant^{-1} (no.)	Panicle weight (g)	Panicle length (cm)	Primary branches (no.)	Secondary branches (no.)	Florets panicle^{-1} (no.)	Grains panicle^{-1} (no.)	Fertility (%)	1000 grain weight (g)	Grain length (mm)	Grain breadth (mm)	Grain L/B ratio	Kernel length (mm)	Kernel breadth (mm)	kernel L/B ratio	Grain yield plant^{-1} (g)
Panicle plant^{-1} (no.)	G	1.000	-0.144	-0.443	-0.267	-0.403	-0.250	-0.022	-0.601	-0.466	-0.410	-0.706**	-0.327	-0.225	-0.225	-0.199	0.527*
	P	1.000	-0.643**	-0.191	-0.134	-0.224	-0.204	0.018	-0.372	-0.312	-0.259	-0.415	-0.178	-0.241	-0.339	-0.016	0.316
Panicle weight (g)	G		1.000	0.308	0.012	0.402	0.247	0.080	0.331	0.281	0.405	0.690**	0.072	0.287	0.571*	-0.059	0.235
	P		1.000	0.250	-0.084	0.273	0.317	0.216	0.155	0.345	0.112	0.330	0.115	0.124	0.203	0.117	0.014
Panicle length (cm)	G			1.000	-0.103	0.269	-0.296	-0.325	0.397	0.898**	0.860**	0.225	0.845**	0.750**	0.119	0.699**	-0.211
	P			1.000	0.074	0.244	-0.114	-0.142	0.180	0.706**	0.480	-0.014	0.511*	0.543*	-0.082	0.594*	-0.215
Primary branches (no.)	G				1.000	0.802**	0.682**	0.620*	-0.241	-0.025	-0.316	0.151	-0.598*	-0.642**	0.100	-0.553*	-0.646**
	P				1.000	0.555*	0.357	0.336	-0.062	-0.051	-0.274	-0.123	-0.278	-0.282	-0.162	-0.271	-0.265
Secondary branches (no.)	G					1.000	0.689**	0.573*	-0.006	0.078	-0.241	0.553*	-0.483	-0.255	0.499*	-0.332	-0.054
	P					1.000	0.385	0.382	-0.073	0.043	-0.127	-0.120	-0.206	-0.150	-0.099	-0.151	-0.076
Floret panicle^{-1} (no.)	G						1.000	0.965**	-0.590*	-0.298	-0.618**	-0.789**	-0.799**	-0.648**	-0.664**	-0.479	0.413
	P						1.000	0.867**	0.022	-0.168	-0.435	-0.158	-0.341	-0.484	-0.139	-0.308	0.156
Grains panicle^{-1} (no.)	G							1.000	-0.781**	-0.488	-0.775**	-0.676**	-0.913**	-0.819**	-0.473	-0.668**	0.509*
	P							1.000	-0.472	-0.321	-0.538*	-0.244	-0.535*	-0.568*	-0.201	-0.405	0.263
Fertility (%)	G								1.000	0.838**	0.002	0.163	0.043	0.060	-0.124	0.958**	-0.495
	P								1.000	0.397	0.375	0.247	0.497*	0.355	0.172	0.337	-0.259
1000 grains weight (g)	G									1.000	0.996**	0.055	0.082	0.875**	0.062	0.769**	-0.196
	P									1.000	0.525*	0.034	0.559*	0.568*	-0.064	0.703	-0.172
Grain length (mm)	G										1.000	0.854**	0.647**	0.066	0.393	0.184	-0.302
	P										1.000	0.340	0.542*	0.905**	0.223	0.599*	-0.277
Grain breadth (mm)	G											1.000	0.334	0.810**	0.885**	0.119	-0.381
	P											1.000	0.130	0.301	0.792**	-0.025	-0.310
Grain L/B ratio	G												1.000	0.548*	0.231	0.127	-0.338
	P												1.000	0.588*	0.032	0.750**	-0.216
Kernel length (mm)	G													1.000	0.377	0.119	-0.219
	P													1.000	0.251	0.662*	-0.178
Kernel breadth (mm)	G														1.000	-0.102	-0.219
	P														1.000	-0.324	-0.102
kernel L/B ratio	G															1.000	-0.099
	P															1.000	-0.117

* Significant at 5 % level ** Significant at 1 % level G: Genotypic correlation coefficient P: Phenotypic correlation coefficient

Table 4. *Path coefficient analysis showing direct (Diagonal bold) and indirect effects of component traits on grain yield RIL's of Basmati derivative*

Characters	Panicle plant^{-1} (no.)	Panicle weight (g)	Panicle length (cm)	Primary branches (no.)	Secondary branches (no.)	Florets panicle^{-1} (no.)	grains panicle^{-1} (no.)	Fertility (%)	1000 grain weight (g)	Grain length (mm)	Grain breadth (mm)	Grain L/B ratio	Kernel length (mm)	Kernel breadth (mm)	kernel L/B ratio	Yield/ correla-tion
Panicle plant^{-1} (no.)	**-0.207**	-0.194	-0.071	0.133	0.003	-0.809	0.059	0.710	0.540	0.085	1.115	-0.017	-0.014	-0.465	-0.342	0.527*
Panicle weight (g)	0.238	**0.169**	0.049	-0.006	-0.003	0.800	-0.220	-0.391	-0.326	-0.084	-1.090	0.003	0.018	1.178	-0.101	0.235
Panicle length (cm)	0.092	0.052	**0.161**	0.051	-0.002	-0.960	0.897	-0.469	-1.041	-0.179	-0.356	0.044	0.047	0.245	1.205	-0.211
Primary branches (no.)	0.055	0.002	-0.016	**-0.501**	-0.006	2.210	-1.711	0.285	0.029	0.065	-0.239	-0.031	-0.040	0.206	-0.954	-0.646**
Secondary branches (no.)	0.083	0.068	0.043	-0.401	**-0.007**	2.231	-1.580	0.007	-0.090	0.050	-0.875	-0.025	-0.016	1.030	-0.572	-0.054
Floret panicle^{-1} (no.)	0.051	0.042	-0.047	-0.341	-0.005	**3.239**	-2.664	0.698	0.345	0.128	1.247	-0.041	-0.041	-1.371	-0.826	0.413
Grains panicle^{-1} (no.)	0.004	0.013	-0.052	-0.310	-0.004	3.126	**-2.760**	0.923	0.565	0.161	1.069	-0.047	-0.051	-0.975	-1.152	0.509*
Fertility (%)	0.124	0.056	0.064	0.120	0.005	-1.912	2.154	**-1.182**	-0.971	-0.208	-0.257	0.054	0.067	-0.255	1.651	-0.495
1000 grains weight (g)	0.097	0.047	0.145	0.012	-0.001	-0.966	1.347	-0.990	**-1.159**	-0.207	-0.086	0.056	0.055	0.128	1.325	-0.196
Grain length (mm)	0.085	0.068	0.139	0.158	0.001	-2.001	2.140	-1.185	-1.154	**-0.208**	-1.351	0.085	0.067	0.811	2.041	-0.302
Grain breadth (mm)	0.146	0.117	0.036	-0.075	-0.004	-2.554	1.866	-0.192	-0.063	-0.178	**-1.581**	0.017	0.051	1.827	0.205	-0.381
Grain L/B ratio	0.068	0.012	0.136	0.299	0.003	-2.587	2.520	-1.233	-1.254	-0.343	-0.528	**0.052**	0.098	0.477	1.943	-0.338
Kernel length (mm)	0.046	0.048	0.121	0.321	0.001	-2.098	2.260	-1.253	-1.014	-0.222	-1.281	0.080	**0.063**	0.777	1.929	-0.219
Kernel breadth (mm)	0.046	0.097	0.019	-0.050	-0.003	-2.150	1.3044	0.146	-0.072	-0.081	-1.399	0.012	0.023	**2.064**	-0.175	-0.219
Kernel L/B ratio	0.041	-0.010	0.113	0.277	0.002	-1.551	1.844	-1.133	-0.891	-0.247	-0.188	0.058	0.071	-0.209	**1.724**	-0.099

Residual effect = 0. .1578 *Significant at 5 % **Significant at 1 %

weight, number of primary branches per panicle, grain length, grain breadth, grain L/B ratio and kernel breadth. It indicated that these characters were highly influenced by environmental effects and controlled by non-additive gene action thus direct selection would be ineffective for these characters.

The genotypic and phenotypic correlation coefficient studies (Table 3) revealed that the magnitude of genotypic correlation coefficient was in general higher than that of the corresponding phenotypic ones. These findings were earlier corroborated by Mamun *et al.,* (2012). Grain yield per plant was significantly positively correlated with number of panicles per plant and number of grains per panicle. Similar findings were reported earlier by Swain and Reddy (2006) for number of panicle per plant and Senapati *et al.*, (2009) for number of panicle per plant and number of grains per panicle. Therefore, number of panicles per plant and number of grains per panicle were the principal yield determining trait in rice.

Path coefficient analysis (Table 4.) revealed that the number of characters, chosen for the study were very much appropriate for yield determination in rice as evident from low value of residual effect (0.1578). Seven characters *viz.* panicle weight, panicle length, florets number per panicle, grain L/B ratio, kernel length, kernel breadth and kernel L/B ratio had positive direct effect on grain yield while the remaining eight characters revealed negative direct effect on grain yield. The floret number per panicle imparted the highest positive direct effect on grain yield per plant. Significantly positive correlation of number of panicle per plant and number of grains per panicle with grain yield in spite of negative direct effect indicated that indirect effects of fertility percentage, 1000 grain weight, grain breadth and grains per panicle would be the cause of such correlation. Therefore, for yield improvement in rice, the present experiment indicates that the characters like fertility percentage, 1000 grain weight and grain breadth should be taken care of. Though floret number per panicle imparted highest direct effect on grain yield per plant, it was non-significantly correlation with grain yield per plant. This was in accordance for kernel length by Kumar and Senapati, 2013. Kernel L/B ratio had high positive direct effect on grain yield per plant but this might have been negated by high negative indirect effects via panicle weight, floret number per panicle, fertility percentage, 1000 grain weight, grain length, grain breadth and kernel breadth leading to its non-significant correlation with grain yield. In this regard a restricted simultaneous selection model is to be followed to make selection effective for kernel L/B ratio and restriction has to be imposed mainly on panicle weight, floret number per panicle, fertility percentage, 1000 grain weight, grain length, grain breadth and kernel breadth to nullify their undesirable indirect effect on grain yield per plant. Shanthala *et al.,* (2004), Mahto and Yadav, (2003) reported similar finding for grain length and grain yield per plant and Kumar and Senapati, (2013) for kernel length.

CONCLUSION

The present investigation highlighted the differential performance of 14 RIL's of Basmati derivative. Six lines (S_{14}, $S_{10,}$ $S_{1,}$ $S_{2,}$ S_3 and S_4) showed very promising performance that may be useful for development of variety in future for gangatic plains of West Bengal. Number of panicle per plant and number of grains per panicle are the prime yield contributing characters and direct selection would be effective in yield improvement in rice.

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Effect of T.S.S. and pH Levels on Quality of Kokum (*Garcinia indica*) Wine

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Wine was prepared from the kokum fruits with different T.S.S. and pH levels of must to study their effect on quality of kokum wine. Five levels of T.S.S. *viz*, 20, 25, 30, 35, 40 ^{0}Brix and three pH levels *viz*, 3.0, 3.5, 4.0 were selected to prepare fifteen types of kokum wine samples. T.S.S., reducing sugars and pH of the wine was increased with increase in T.S.S. levels of fruit. No specific trend of anthocyanin and tannin content was observed with increase in T.S.S. levels. The wine prepared from 25 ^{0}Brix T.S.S. level and 4.0 pH was found to be best considering the chemical composition and sensory evaluation of wine.

(Key words: *Kokum wine, T.S.S., pH, Quality)*

In India, Kokum (*Garcinia indica*) is grown widely in tropical rain forest of western ghat mainly Konkan region of Maharashtra, Goa, South Karnataka, Coorg, Wyanand, the lower slopes of Nilgiri hills and also in Andaman. In these areas, kokum is planted in the backyard or in orchards. In Konkan region of Maharashtra it is planted in almost every household though the exact area is not known it is estimated to be on the area of 1000 ha which produces 4,500 tonnes of kokum fruits (Anonymous, 2008). The fresh kokum rind contains moisture 80 per cent, protein 1.92 per cent, crude fibre 14.28 per cent, total ash 2.57 per cent, tannin 2.85 per cent, pectin 5.71 per cent, starch 1 per cent, crude fat 10 per cent, acid (as hydroxy citric acid) 22.80 per cent, pigment 2.40 per cent, ascorbic acid 0.06 per cent, carbohydrades by difference 35 per cent (Anonymous, 2005). Being fruit based fermented and undistilled product; wine contains most of the nutrients present in the original fruit juice. The nutritive value of wine is increased due to release of amino acids and other nutrients from yeast during fermentation. Fruit wines contain 8 to 11 per cent alcohol and 2 to 3 per cent sugar with energy value ranging between 70 and 90 Kcal per 100 ml.

The therapeutic properties of the kokum fruit have been described in traditional medicine ayurveda. These include its usefulness to relieve sunstroke, very good appetizer, as a cardiotonic, for tumours and heart diseases. It is also known to contain hydroxy citric acid (HCA), a potential anti-obesity agent and fights cholesterol. The juice of ripe fruit have appealing red colour. It was therefore, thought to utilize ripe kokum fruits for wine preparation. By developing such technology, the post harvest losses in kokum fruit can be reduced. This will also help to generate rural employment in addition to higher returns to the farmers. Taking this into account, the present study entitled "Effect of T.S.S. and pH levels on quality of kokum wine" was undertaken to study the effect of T.S.S. and pH levels on chemical composition and sensory evaluation of wine, for quality wine production.

MATERIALS AND METHODS

The present investigation was carried out at Fruit Beverages Research Center, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli during the year 2011-2012. For this study well riped kokum fruits were collected from trees present on the educational farm of the university. Fruits were washed with water and then cut with kokum cutter machine. Rind and seeds were separated and juice was extracted from rind with the help of basket press machine. The juice was kept overnight under cold storage (12^{0}C) after treating with pectinase enzyme (0.1%). Next day clear juice was obtained by decanting and used for preparation of must (Fig. 1). Must was prepared by adjusting the T.S.S. of juice to 20, 25, 30, 35 and 40^0 Brix by addition of sugar and adjusting pH to 3.0, 3.5 and 4.0 by addition of calcium carbonate. The juice was supplemented with 0.1 per cent diammonium hydrogen phosphate (DAHP) and potassium metabisulphite (KMS) equivalent to 30 ppm SO_2. The prepared must of

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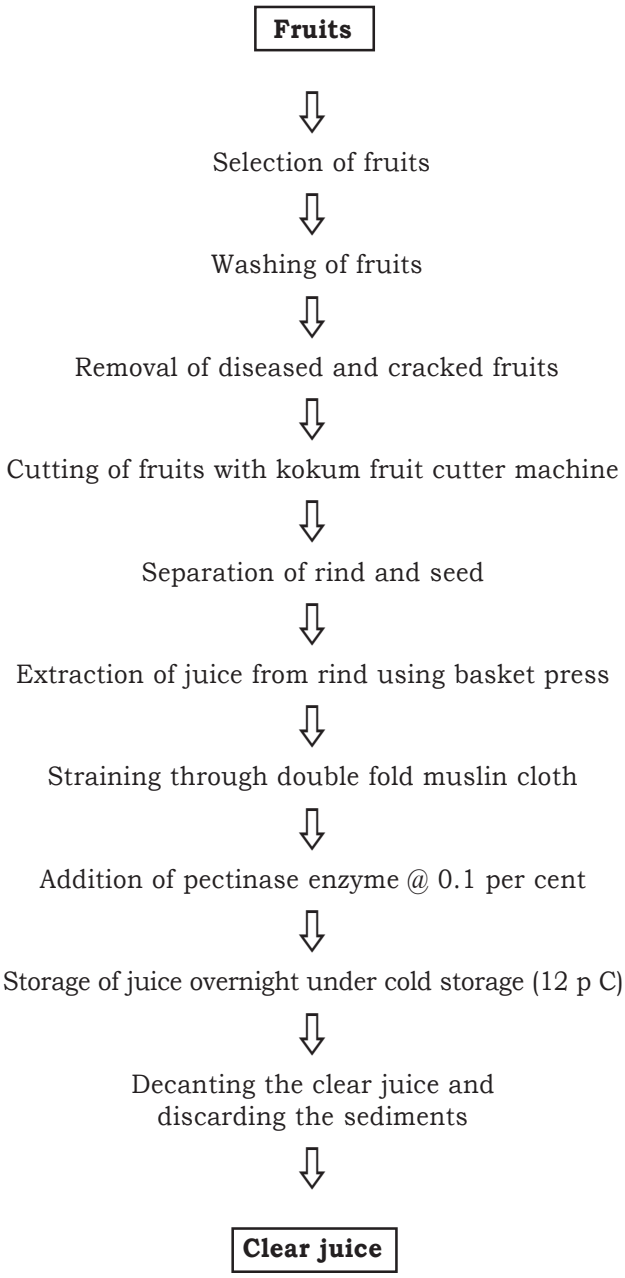

Fig. 1. Extraction of juice from kokum fruits

each interaction (1.0 kg) after pasteurization at 82°C for 20 minutes, was inoculated with yeast powder (*Sacchraromyces cerevisiae var. bayanus*) at the rate of 0.3 g kg^{-1} of must for fermentation (Fig. 2). The prepared wi Anonymous, ne was analysed for the chemical composition and sensory evaluation. The T.S.S. content of wine was determined by using Erma hand refractometer (A.O.A.C., 1975). The reducing sugar, titratable acidity, anthocyanin and tannin content were determined as per the procedures described by Ranganna (1977). The pH was measured by Systronics ìpH system 361. The alcohol content in wine was determined by the method as reported by Natu *et al.*, (1986). The sensory evaluation of kokum wine was carried out by scoring wines numerically on a 20 point score card given by Ough and Baker (1961).

RESULTS AND DISCUSSIONS

Results of the chemical composition of wine are presented in table 1 to 4. The T.S.S. and pH levels and their interactions showed significant results with respect to all the chemical parameters studied. It is seen from tables that T.S.S., reducing sugars and pH of the wine was increased with increase in T.S.S. levels, irrespective of pH levels, except few exceptions. However, titratable acidity was found to be decreased with increase in T.S.S. levels. Increase in T.S.S. and reducing sugars of wine with increase in T.S.S. level may be the impact of original adjusted T.S.S. levels. Similar findings have been reported by Anand (2003) while evaluating cashew apple for wine making. Decrease in titratable acidity of wine with increase in T.S.S. level may be due to addition of sugar in increasing trend to maintain T.S.S. levels of must, which might have diluted the native acids. More (2010) and Sapkal (2011) recorded no specific trend of titratable acidity with increase in T.S.S. levels while preparing wine from karonda and Alphonso mango, respectively. Increase in pH with increase in T.S.S. level may be due to decrease in acidity of wine with increase in T.S.S. level.

No specific trend of anthocyanin and tannin content was observed with increase in T.S.S. levels. Treatment T_1 recorded highest anthocyanin content (1463.6 mg 100 g^{-1}) and it was significantly superior over others. No specific trend observed in tannin content may be due to reduction in tannins by oxidation of tannins and precipitation with proteins in varying degree. Sapkal (2011) reported non significant results in tannin content of Alphonso mango wine with respect to T.S.S. levels. The alcohol content of wine was found to be increased from T_1 (4.92 %) to T_2 (8.35 %) and thereafter it showed decreasing trend. Increase in alcohol content till T_2 may be due to better fermentation at T_2 level of T.S.S. Similar increase in alcohol with increase in T.S.S. level was recorded by More (2010) with karonda wine. However, decrease in alcohol content at higher levels of T.S.S. may be the effect of high concentration of sugars at T_3, T_4, and T_5 levels which affected yeast activity and ultimately the conversion of sugars to alcohol.

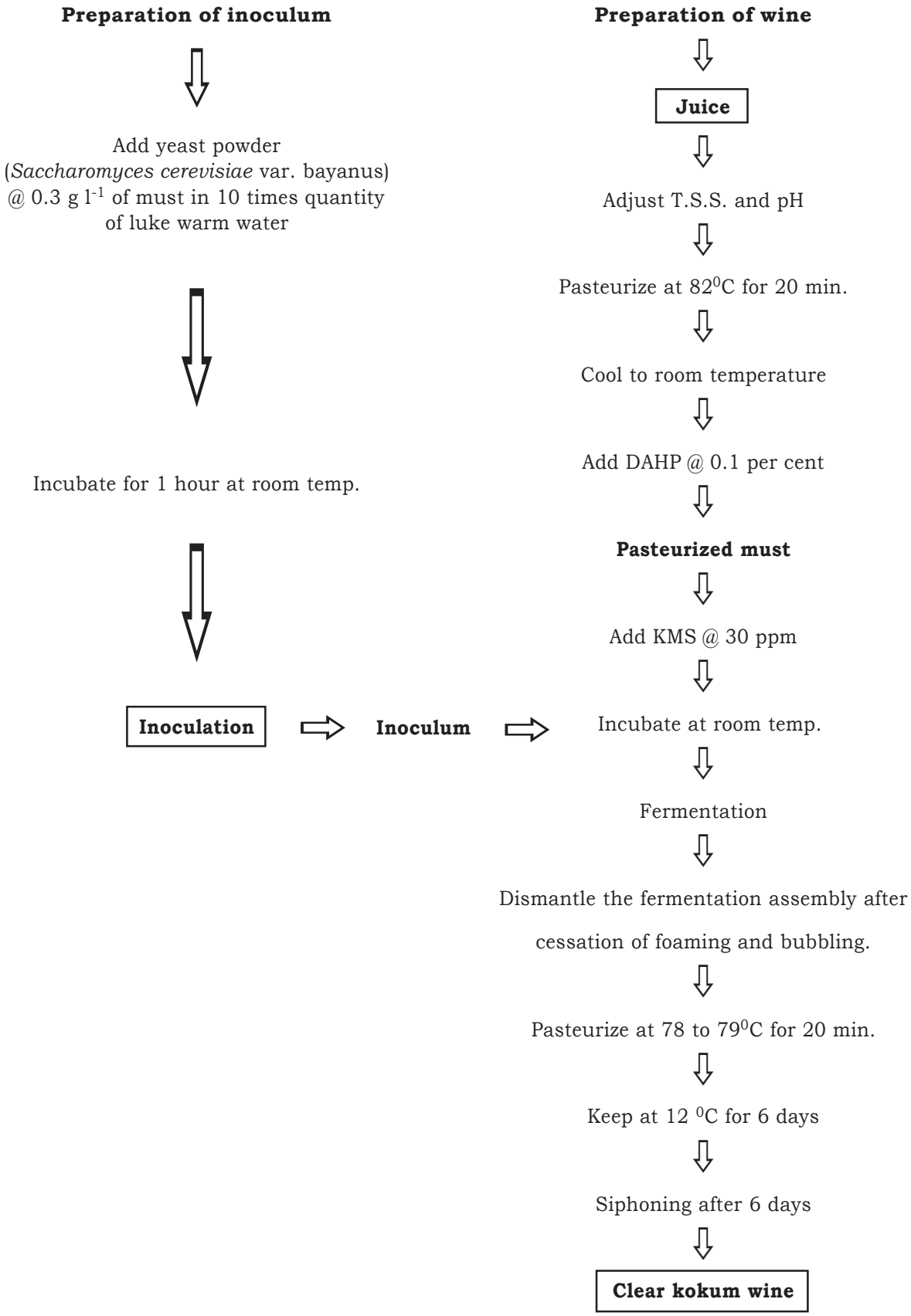

Fig. 2. Preparation of wine from kokum juice

Table 1. *Effect of T.S.S. and pH levels on T.S.S. and reducing sugar content of kokum wine*

pH levels	T.S.S. (ºBrix)						Reducing sugars (%)					
	T.S.S. levels											
	T_1(20 ^{0}B)	T_2(25 ^{0}B)	T_3(30 ^{0}B)	T_4(35 ^{0}B)	T_5(40 ^{0}B)	Mean	T_1(20 ^{0}B)	T_2(25 ^{0}B)	T_3(30 ^{0}B)	T_4(35 ^{0}B)	T_5(40 ^{0}B)	Mean
P_1(3.0)	19.60	18.20	22.40	34.80	39.60	26.92	2.97	3.37	5.00	5.34	6.48	4.63
P_2(3.5)	10.80	11.20	18.20	24.40	32.20	19.36	0.30	1.31	2.25	3.07	3.98	2.18
P_3(4.0)	8.00	8.80	14.20	21.60	26.80	15.88	NT	0.28	1.25	2.52	2.72	1.35
Mean	12.80	12.73	18.27	26.93	32.87	20.72	1.09	1.65	2.83	3.64	4.39	2.72

	SEm +	CD at 1%	SEm +	CD at 1%
T.S.S. levels (T)	0.115	0.479	0.011	0.046
pH levels (P)	0.089	0.371	0.009	0.038
Interactions (T×P)	0.200	0.833	0.019	0.079

NT– Not traceable

Table 2. *Effect of T.S.S. and pH levels on titratable acidity and pH of kokum wine*

pH levels	Titratable Acidity (%)						pH					
	T.S.S. levels											
	T_1(20 ^{0}B)	T_2(25 ^{0}B)	T_3(30 ^{0}B)	T_4(35 ^{0}B)	T_5(40 ^{0}B)	Mean	T_1(20 ^{0}B)	T_2(25 ^{0}B)	T_3(30 ^{0}B)	T_4(35 ^{0}B)	T_5(40 ^{0}B)	Mean
P_1(3.0)	1.44	1.60	1.30	1.28	1.12	1.35	2.86	2.74	2.97	3.07	2.94	2.92
P_2(3.5)	1.00	0.99	0.97	0.96	0.80	0.94	3.63	3.32	3.45	3.61	3.74	3.55
P_3(4.0)	0.92	0.80	0.66	0.64	0.48	0.70	3.72	3.86	3.87	3.93	4.03	3.88
Mean	1.12	1.13	0.98	0.96	0.80	1.00	3.40	3.31	3.43	3.54	3.57	3.45

	SEm +	CD at 1%	SEm +	CD at 1%
T.S.S. levels (T)	0.012	0.050	0.012	0.050
pH levels (P)	0.009	0.038	0.009	0.038
Interactions (T×P)	0.02	0.083	0.02	0.083

Table 3. *Effect of T.S.S. and pH levels on anthocyanin and tannin content of kokum wine*

pH levels	Anthocyanin (mg 100 g^{-1})						Tannins (%)					
	T.S.S. levels											
	T_1(20 ^{0}B)	T_2(25 ^{0}B)	T_3(30 ^{0}B)	T_4(35 ^{0}B)	T_5(40 ^{0}B)	Mean	T_1(20 ^{0}B)	T_2(25 ^{0}B)	T_3(30 ^{0}B)	T_4(35 ^{0}B)	T_5(40 ^{0}B)	Mean
P_1(3.0)	2164.0	1420.0	1222.0	1965.0	1729.0	1700.0	0.115	0.090	0.096	0.120	0.116	0.107
P_2(3.5)	1037.0	762.0	1181.0	992.0	806.0	955.6	0.079	0.073	0.091	0.089	0.098	0.086
P_3(4.0)	1190.0	1079.0	945.0	913.0	771.0	979.0	0.076	0.068	0.082	0.088	0.088	0.080
Mean	1463.6	1087.0	1116.0	1290.0	1102.0	1211.7	0.090	0.077	0.090	0.099	0.101	0.091

	SEm +	CD at 1%	SEm +	CD at 1%
T.S.S. levels (T)	9.859	41.085	0.0012	0.0050
pH levels (P)	7.637	31.825	0.0009	0.0038
Interactions (T×P)	17.076	71.160	0.002	0.0083

Table 4. *Effect of T.S.S. and pH levels on alcohol content of kokum wine*

	Alcohol (%)					
pH levels	T.S.S. levels					
	T_1(20 ^{0}B)	T_2(25 ^{0}B)	T_3(30 ^{0}B)	T_4(35 ^{0}B)	T_5(40 ^{0}B)	Mean
P_1(3.0)	0.33	5.38	5.70	1.77	0.59	2.75
P_2(3.5)	6.43	8.20	6.43	6.16	5.57	6.56
P_3(4.0)	8.00	11.48	8.59	8.66	7.80	8.91
Mean	4.92	8.35	6.91	5.53	4.65	6.07

	SEm +	CD at 1%
T.S.S. levels (T)	0.027	0.113
pH levels (P)	0.021	0.088
Interactions (T×P)	0.047	0.196

Table 5. *Sensory evaluation of kokum wine*

Sr. No.	Treatment	Colour and Appearance	Body	Aroma	Taste	Astringency	Overall Acceptability	Overall quality (average score)
1	$T_1 P_1$	10	6	7	8	9	7	8
2	$T_1 P_2$	14	9	12	8	10	9	10
3	$T_1 P_3$	13	10	12	9	10	10	11
4	$T_2 P_1$	11	8	10	9	10	9	10
5	$T_2 P_2$	14	11	10	11	11	12	12
6	$T_2 P_3$	14	13	13	12	12	13	13
7	$T_3 P_1$	9	8	10	10	10	10	10
8	$T_3 P_2$	14	11	13	11	11	11	12
9	$T_3 P_3$	13	12	13	12	12	13	13
10	$T_4 P_1$	10	7	7	8	8	7	8
11	$T_4 P_2$	13	11	11	12	11	11	12
12	$T_4 P_3$	13	12	12	12	13	13	13
13	$T_5 P_1$	9	7	7	7	8	7	8
14	$T_5 P_2$	12	10	10	9	11	10	10
15	$T_5 P_3$	12	10	9	9	11	10	10
16	Reference	16	16	14	14	15	16	15

Score Range	Rating
9-12	Commercially acceptable wines
13-16	Standard wines
17-20	Superior quality wines

With respect to pH levels, the pH and alcohol content of wine showed increasing trend with increase in pH levels. The increase in pH may be due to initial adjustment of pH levels in the must. Observation analogous to these findings have also been reported by Jagtap (2010) in jamun wine. Increase in alcohol content with increase in pH levels may be due to better conversion of reducing sugars in to alcohol during fermentation with increase in pH levels. The T.S.S., reducing sugar, titrarable acidity and tannin content of wine showed decreasing trend with increase in pH level. Decrease in T.S.S. and reducing sugar may be due to better fermentation of must and formation of alcohol. Decrease in titratable acidity may be due to increase in pH with increase in pH levels. This observation was in agreement with the findings of More (2010) in karonda wine. The anthocyanin content of wine

did not showed specific trend with respect to pH levels. Among the different interactions of T.S.S. and pH levels the lowest T.S.S., reducing sugar, pH and tannin content of wine was observed in the treatment combinations T_1P_3, T_1P_3, T_2P_1, and T_2P_3, respectively. The maximum acidity, anthocyanin and alcohol content were observed in the treatment combinations T_2P_1, T_1P_1 and T_2P_3, respectively.

The results regarding sensory evaluation of kokum wine are presented in Table 5. It is seen from table that wines prepared from interactions T_2P_3, T_3P_3 and T_4P_3 recorded highest (13.0) overall quality score for sensory quality and these wines fell under the rating of standard wines and compared well with reference wine. From the present findings it can be concluded that standard quality wines can be prepared from ripe kokum fruit juice by adjusting the pH of the must to 4.0 and T.S.S. to 25, 30 and 35° Brix. However among these three wines T_2P_3 (T.S.S. 25^0 B and pH 4.0) was found to best considering the chemical composition of wine along with sensory quality.

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Groundwater Pumping Options in Coastal Areas of Odisha

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Odisha has a long coast line stretching over 480 km in length along the eastern boundary of Bay of Bengal. These areas are highly sensitive in terms of saline water intrusion due to excessive groundwater pumping to meet the water requirement of increasing population and crop water demand. It is necessary that safe pumping options should be strictly followed to maintain sustainable groundwater withdrawal. This papers deals with estimation of optimal pumping options in two coastal districts of Odisha, *i.e.* Kendrapara and Jagatsinghpur, that occupies 2nd and 4th highest position in terms of groundwater development status within the State. Field studies were carried out to characterize the groundwater table depth fluctuation, change in water quality, aquifer properties, and specific capacity of the study area. Pumping test results in the study area showed that transmissivity value of aquifer ranged within 68.2 to 786.8 m^2 day^{-1}. Groundwater quality within the shallow aquifer was within the permissible limit of irrigation use. Due to presence of good aquifer zones and source of groundwater recharge, groundwater can be exploited safely in these areas. An analytical approach by using the Ghyben-Herzberg model has been used to calculate the total fresh water flow towards sea, safe pumping depth, well density, pumping mode within the study area. The model result indicated that even though both districts are sensitive to salinity, depth of pumping should be restricted within 6-9.5m and 16 to 24.5m in Erasama, Kendrapara areas respectively. Similarly well density could be restricted upto 1-2 numbers per square kilometer along the coast line. Smaller horse power pumps with 1-3 hp could be effectively used continuously for 4/5 hours in order to avoid saline intrusion in these areas.

(**Key words**: Coastal area, Salinity, Groundwater, Pumping options)

Coastal aquifers are the richest groundwater reservoirs which are always under stress due to increase in population growth and higher demand of water for agricultural and industrial requirements. The Intergovernmental Panel on Climate Change (IPCC, 2001) predicts that by 2100, global warming will lead to a sea-level rise which will result to in the inland migration of the mixing zone between fresh and saline water (FAO 1997). This may result salinity intrusion in the coast line, hence while extracting and using groundwater, it is necessary to maintain the balance between the amount of water extracted from the aquifer and amount of water being recharged to the aquifer.

Variable density flow and solute transport simulation of aquifer systems containing narrow transition zones between freshwater and saltwater requires particular attention to certain aspects of the numerical method and its application to be successful (Voss and Souza, 1987). In Odisha, coast line has been stretched around 480 km along the Bay of Bengal. Average groundwater development in Odisha is 26.14%, highest in Bhadrak (55.49%) followed by Kendrapara (52.8%), Balasore (48.58%) and Jagatsinghpur (47.37%) (DGSI, 2011). All these districts are located in the East coast of Odisha covered under East and South Eastern Coastal Plain agro-climatic regions, prone to occurrence of various calamities like flood, cyclone and drought. Similarly due to good amount of groundwater available at shallow depth, there is ample opportunity to grow three crops in a year and improve water use efficiency/water productivity of the irrigation project (Singandhupe *et al.*, 2009). Out of all coastal districts, Kendrapara and Jagatsinghpur districts faces problems like saline soils, water logging, which adversely affects the production and productivity. Few areas (blocks) in these districts are already under fully salinity affected areas where groundwater development is strictly banned. But, as per the groundwater assessment report, many blocks in these areas have a lot of groundwater potential which can be utilized for irrigation. It is necessary that safe withdrawal of groundwater should be quantified in order to check salinity ingression. In this paper an attempt has been tried to define the safe pumping options and pumping schedule in coastal areas of Odisha by analytical

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approach which ensures sustainable use of groundwater.

MATERIALS AND METHODS

The study area was selected in Erasama block of Jagatsinghpur district and Garadpur block of Kendrapara district of Odisha. Most of the coastal areas of Odisha are surrounded by the river Mahanadi River and its distributaries and Bay of Bengal forms the eastern boundary of the district. Rainfall analysis was carried out by using data from 1994-2009. Potential Evapotranspiration (PET) was estimated by using Hargreaves method. Water budget for both areas were calculated based on the crop water requirements. Groundwater scenario and hydro geological information has been collected from report of CGWB and Directorate of Groundwater Survey and Investigation, Bhubaneswar. Depth to water table (1997-2009) from different monitoring wells located in all the selected blocks were analyzed to determine the average pre and post monsoon water table fluctuation. Pumping test has been carried out in bore wells and dug wells to determine the aquifer properties of the area.

Analytical approach

For coastal areas, salt water intrusion is the migration of saltwater into freshwater aquifers under the influence of groundwater development (Freeze and Cherry, 1979). As per this, the change of seawater thickness in the aquifer depends on the change of fresh-water thickness. The increase of saltwater thickness has been amplified by as many as 33 times, depending on the specific weight of the freshwater and the seawater. The distribution of freshwater head along this boundary is a function of saline water depth and the difference in their respective densities. The depth to the freshwater/ saltwater interface in a coastal aquifer under steady-state conditions is approximately 33 times the height of the freshwater head (h_f) above sea level. Development of interface of seawater and freshwater, determination of hydraulic gradient and estimation flow to sea, pumping depth and pumping density has been estimated based on this methodology.

***Table 1**. Groundwater status of Kendrapara and Jagatsinghpur districts of Odisha*

	Ground water resources (ha m)	Percentage of total draft used for irrigation (%)	Ground water development (%)	Dug wells (Shallow aquifer)		Bore wells (Deep aquifer)	
				Pre monsoon water table depth (m)	Post monsoon water table depth (m)	Pre monsoon water table depth (m)	Post monsoon water table depth (m)
Kendrapara							
Kendrapara	2422	92.00	46.49	4.92	2.62	4.43	3.66
Derabis	4096	92.50	43.33	5.52	3.11	2.53	1.49
Marshaghai*	–	–	–	5.33	2.01	3.24	1.67
Mohakalpara*	–	–	–	6.15	3.97	2.73	1.83
Garadapur	3700	90.69	67.95	4.72	2.45	3.53	2.00
Pattamundai	5799	94.88	53.54	7.08	4.94	2.97	1.66
Aul	764	87.09	44.63	4.45	2.42	3.71	1.86
Rajnagar*	–	–	–	5.81	2.90	–	–
Rajkanika*	–	–	–	–	–	3.14	2.06
Jagatsinghpur							
Jagatsinghpur	8222	–	–	4.06	0.94	2.68	1.16
Biridi	6814	93.64	44.09	3.71	1.35	2.87	1.58
Raghunathpur	7340	91.01	31.53	4.21	2.64	2.93	1.85
Balikuda	5052	87.02	42.99	4.24	2.35	-	-
Naugaon	2786	93.49	67.26	3.83	1.63	2.89	1.87
Tirtol	8406	92.34	52.64	3.78	1.52	2.90	1.78
Kujanga	6409	89.62	62.38	3.27	1.36	2.21	1.43
Erasama*	–	–	–	3.75	1.78	2.43	1.21

*Blocks affected by salinity, - indicates no data available

RESULTS AND DISCUSSION

Annual replenishable groundwater resources, average groundwater development, pre and post monsoon water table depth in shallow and deep aquifer in Kendrapara and Jagatsinghpur districts is shown in Table 1. Out of total groundwater resources only 2-3% is being utilized for irrigation in both Kendrapara and Jagatsinghpur district. In case of shallow aquifer, water table depth in dug wells varied within 4.45 to 7.08m and 2.01 to 4.94m during pre and post monsoon periods in Kendrapara. But water table depth in deep aquifers through shallow tubewells varied within 2.53 to 4.43m and 1.49 to 3.66m during pre and post monsoon periods in Kendrapara. Similarly in Jagatsinghpur, shallow aquifer water table depth in dug wells varied within 3.27 to 4.24 m and 0.94 to 2.63m during pre and post monsoon periods respectively. But water table depth in deep aquifers through shallow tubewells varied within 2.21 to 2.93 m and 1.16 to 1.87m during pre and post monsoon periods in Jatsinghpur respectively. Average groundwater development varied within 44. 63% in Derabish block to 67.95% in Garadpur block of Kendrapara. It varied within 31.53% in Raghunathpur to 67.26% in Nuagaon block of Jagatsinghpur districts. This showed the maximum use of groundwater resources. Kendrapara district receives maximum rainfall of 1334.57mm (84%) during monsoon period when evaporative demand is 498.74mm only. Rest other months the district receives 240.13mm of rainfall against demand of 1120.56mm (Fig. 1). Jagatsinghpur district receives rainfall of 1538mm (86%) during monsoon period against evaporative demand of 503.5mm whereas, non monsoon rainfall is only 225.3mm against demand of 1132.65mm (Fig. 2). Groundwater pumping is maximum during the *Rabi* (November-February) and summer (March-June) months in these areas. In these areas groundwater is being used to irrigate *Rabi* crops like pulses, vegetables, sugarcane, sunflower, jutes etc. Maximum numbers of shallow tubewells i.e. 2969 (Kendrapara) and 6004 (Jagatsinghpur) followed by dug wells 1452 (Kendrapara) and 2907 (Jagatsinghpur). Coastal alluvial areas are blessed with good aquifer (high discharge and low water table depth), which results in comparatively low energy requirement to lift the groundwater. However, these areas are prone to salinity intrusion, hence regional aquifer properties need to be understood for determining the safe groundwater pumping options. Hence pumping test was carried out in few areas to know the status of groundwater resources.

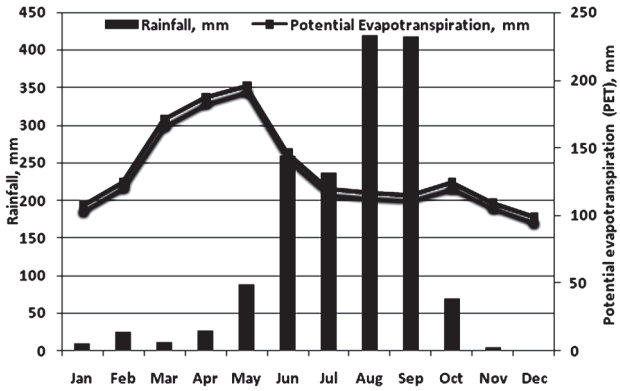

Fig. 1. Water Budget for Kendrapara Districts

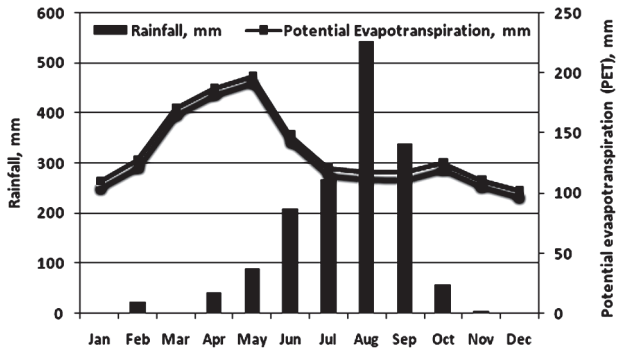

Fig. 2. Water Budget for Jagatsinghpur Districts

Pumping test analysis

Pumping test was conducted in selected dug wells in Erasama village of Jagatsinghpur district and Dahalpur village of Garadpur block of Kendrapara district. Static water table depth varied within 1.2 m to 2.1 and 4.4m to 6.5m in pre monsoon periods (February) in Erasama and Kendrapara respectively. Pumping test results showed that transmissivity varied within 197-275 m^2 day^{-1}. Aquifer thickness were 10-55m and hydraulic conductivity ranged between 4-330 m day^{-1}. The average discharge rate, static water table depth, total water pumped from shallow tubewells, recuperation rate for Dahalpur shown in Table 2. In case of dug wells, pumping test results showed on an average, 76.67%, 81.8% water is recuped from recharge in Dahalpur and Srirampur village of Kendrapara respectively. Recharge rate was estimated at 7.61 and 13.7 m^3 hr^{-1} for all areas.

Analytical approach to determine pumping options

Ghyben-Herzberg approach was used for 1 km width strip, stretched from 1-15 km away from the coast line for both Erasama and Kendrapara blocks. Likewise 5 strips have been considered to determine the freshwater flow towards sea, hydraulic gradient

Table 2. *Pumping test (Shallow tubewell) results in Dahalpur village*

Sl. No	Average discharge (ls^{-1})	Static water table depth (m)	Pumping water level (m)	Drawdown (m)	Total water pumped (m^3)	Recuperation rate ($m^3\ hr^{-1}$)	Specific capacity ($m^3\ hr^{-1}\ m^{-1}$)
1	7.5	4.4	7.9	3.5	108.0	24.00	86.40
2	7	5.8	8.1	2.3	75.6	18.90	87.65
3	3.5	4.9	7.6	2.7	50.4	14.40	46.67
4	10	5.5	7.8	2.3	126.0	31.50	125.22
5	12	6.4	7.5	1.1	172.8	28.80	314.18
6	7	5.4	7.3	1.9	113.4	22.68	132.63
7	3.5	5.6	6.9	1.3	63.0	15.75	116.31
8	18	6.5	6.8	2.3	259.2	37.03	140.87
9	6	5.7	8.2	2.5	108.0	15.43	51.84
10	8	5.6	7.9	2.3	115.2	28.80	87.65
Avg	8.27	5.4		2.2	119.16	23.73	131.03

Table 3. *Safe pumping depth along coast line in Erasama*

Strip No.	Distance from sea (km)	Depth to water table (m)	C/S area for flow (m^2)	Q_{total} ($m^3\ day^{-1}$)	Pumping volume ($m^3\ day^{-1}$)	Pumping depth (m)
1	15	0.39	6825	307.13	153.56	6.44
2	15	0.42	7315	329.18	164.59	7.35
3	15	0.38	6650	299.25	149.63	6.65
4	15	0.54	8910	400.95	200.48	9.45
5	15	0.42	7350	330.75	165.38	7.35

Table 4. *Safe pumping depth along coast line in Kendrapara*

Strip No.	Distance from sea (km)	Depth to water table (m)	C/S area for flow (m^2)	Q_{total} ($m^3\ day^{-1}$)	Pumping volume ($m^3\ day^{-1}$)	Pumping depth (m)
1	15	0.808	16660	299.88	149.94	17.15
2	15	0.745	16830	302.94	151.47	17.33
3	15	1.282	25670	462.06	231.03	26.43
4	15	0.835	16150	290.70	145.35	16.63
5	15	0.936	20400	367.20	183.60	21.00

and fresh-saline water interface. The hydraulic conductivity value was taken as 50 and 20 m day^{-1} for Erasama and Kendrapara respectively. The hydraulic gradient of shallow fresh water was very low which ranged within 0.0004-0.0009. Then from 15 km strip, total flow towards sea was estimated for both areas and presented in Table 3 and 4. It showed that total flow varied from 308 to 400 $m^3\ day^{-1}$ and 300 to 460 $m^3\ day^{-1}$ in Erasama and Kendrapara blocks respectively. Assuming pumping volume as half of the total flow and pumping depth as half of the water table fluctuation during pre and post monsoon seasons, safe pumping depth should be restricted within 6.4m to 9.4m and 17 to 20 m in Erasama and Kendrapara areas. Based on the aquifer properties, it was calculated that small pumps within 1-3 hp should be used for pumping groundwater in these areas. From the analytical model it was estimated that well density could be restricted upto 1-2 numbers per square kilometer along the coast line. Smaller horse power pumps could be effectively used continuously for 4/5 hours in order to avoid saline intrusion in these areas. However, these initial results are based on analytical modeling with limited field observations which will be further refined with additional field data.

CONCLUSIONS

Coastal areas of Odisha are prone to sea water intrusion due to excessive pumping. A conceptual model (Ghyben- Herzbeg approach and basic groundwater flow concepts) suggested restriction of pumping depth within 6m to 20m with maximum of two (1-3 hp) pumps per square kilometer for maximum of 4-5 hours of continuous pumping to check saline water ingression and ultimately energy consumption pattern in coastal tract of Odisha.

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Length-Weight Relationship and Condition Factor of *Amblypharyngodon mola* (Hamilton-Buchanan, 1822)

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The Mola Carplet, *Amblypharyngodon mola* (Hamilton-Buchanan, 1822) is very popular fish in West Bengal due to its high nutritive status, rich in micro nutrients and its palatable taste. In West Bengal it is locally known as *mourala* or *mola*. The study of length-weight relationship of fishes provides a mathematical relationship between Length (L) and Weight (W) as a means of inter-conversion for estimating the weight from the known length and vice-versa. In the present study L-W relationship and condition factor of *A. mola* were estimated from 910 samples collected from different locality of South 24 Parganas during Feb. 2011 to Feb. 2014. The total length ranged from 20 to 87 mm and the total body weight ranged from 0.07 to 6.97g. The scatter diagram showed the linear relationship in between the Log length and Log weight of the fish. The relationship of length and weight was found positive and highly significant justifying a strong relationship between L-W of *A. mola* (r=0.97). The functional form of relationship between L-W of the species is fitted as Log W= -6.08 + 3.57 Log L. The equation is a very good fit as seen from the coefficient of determination value (R^2 = 0.95). The 'b' value (b=3.57) is more than 3 indicating the positive allometric growth of the fish and found to be significantly different at 1% level. The fish does not follow the cube law strictly. The mean condition factor of the fish was found to 0.85 indicating extremely poor fish, thin body.

(Key words: *Mourala, Amblypharyngodon mola, Length-weight relationship, Condition factor)*

The study of length-weight relationship (L-W relationship) of fishes provides a mathematical relationship between length and weight as a means of inter-conversion for estimating the weight from the known length and vice-versa. Knowledge of the L-W relationship of a fish is essential, since various important biological aspects, viz., general wellbeing of fish, appearance at first maturity, onset of spawning etc. can be assessed with the help of condition factor (Le Cren, 1951). L-W relationship as well as the condition factors is useful parameters for assessing the well-being of the individuals and for determining possible differences among different stocks of the same species (King, 2007). L-W relationship is important in fisheries science, notably to raise length-frequency samples to total catch, or to estimate biomass from underwater length observations (Pal *et al.,* 2013). When the b-value is less than 3, the fish has a negative allometric growth but when it is greater than 3, it has a positive allometric growth and when it is equal to 3, the fish has isometric growth (Khairenizam and Norma-Rashid, 2002).

The food habits, physiological factors like maturity and spawning play an important role on the length-weight relationship of fishes (Mahapatra and Datta, 1998). Among the small indigenous fish species, the Mola Carplet, *Amblypharyngodon mola* is very popular fish in West Bengal as well as in Eastern India. In West Bengal it is locally known as mourala or mola. It is a fresh water species, distributed in India, Bangladesh, Pakistan and Myanmar (Talwar and Jhingran, 1991). Mola carplet is categorized as least concerned by IUCN (Chaudhry, 2010). The culture of the species has drawn the attention of both the aquaculture researchers and the farmers due to its high consumer preference owing to its palatable taste, rich in micro-nutrients (Vitamins, Minerals, Amino acids) especially, calcium in desirable quantity that can cater the nutritional requirement of lactating, pregnant mother and the growing child (Zafri and Ahmed, 1981, Thilsted, 2003 and Saha *et al.,* 2009). Mahapatra *et al.,* (2007) and Gupta and Banerjee (2012) reported that Mola is a good candidate species for ornamental fish trade, for its shiny silvery look. The earlier workers Hossain (2010), Hossain *et al.,* (2006), Baishya *et al.,* (2010) and Gogoi and Goswami (2014) worked on length-weight relationship of *A. mola*. Keeping in view of the importance of this species, the present study was planned to study the L-W relationship and condition factor of *A. mola*.

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MATERIALS AND METHODS

Collection of the sample

A total 910 nos. specimens of *A. mola* belonging to all available size classes and both sexes male and female were taken into account to study L-W relationship and condition factor. They were collected randomly mostly from Kolkata and sub-urban fish markets (Behala, Garia, Sheoraphuli fish market), ponds of Taldi located at South 24 Parganas district of West Bengal during Feb-2011 to March-2014. All samples were brought to laboratory in ice and then frozen until processing.

Computational formula for Length-Weight relationship

The fishes were thawed, cleaned, and air dried. The measurements for length and weight were taken using an accurate scale and an electronic balance respectively. The total length was recorded from the tip of the snout to the tip of the caudal fin in millimetre. The weights were taken to one tenth of a gram. The L-W data were analysed according to the method mentioned by Le Cren (1951). In the present study, the equation of the parabolic relationship of the form $W = aL^b$ was used where, W represents weight of the fish in g,. L being the total length in mm and 'a' the constant and 'b' an exponent to which L can be raised. The equation expressed in logarithmic form becomes: Log W = Log a + b Log L. The equation was calculated for combined sample and a linear relationship between the logarithm length and logarithm weight was found from the scatter diagram. The coefficient of correlation and the regression line was calculated and drawn from the formula given by Spiegel (1972). The calculations were based on log values length and weight of the fish species. To test the regression coefficient,'t' test was done according to the method given by Snedecor (1961). All data were analysed by using Statistical Package for Social Sciences (SPSS-16.0) and MS Excel.

Condition Factor

The following formula as given by Fulton (1902) was used to express the condition factor:

$$K = \frac{\text{Weight} \times 10^5}{(\text{Length})^3}$$

Where, W denotes weight of the fish in g, L = total length of the fish in mm.

RESULTS AND DISCUSSION

Descriptive statistics

The descriptive statistics of combined group of length weight data was presented in Table 1. It appeared that the length of *A. mola* ranged from the 20.00 to 87.00mm and weight ranged from 0.07 to 6.97g. The maximum and the minimum length of *A. mola* was recorded 48mm and 74mm respectively from Padma River and the observed mean length and the mean weight were 56.85 mm and 1.77g, respectively (Hossain, 2010). In the present study the female was found significantly larger than male *A. mola* fish. In case of length and weight the value of coefficient variance (CV) was 551.66% and 156.04%, respectively indicating the relative variation of the L-W of the species.

Scatter diagram

The L-W data of *A. mola* was collected and converted into logarithm form to estimate the length weight relationship and made it linear form for estimation of regression parameters. The L-W data was presented in the form of scatter diagram. From the scatter diagram we see that the relationship is linear (Fig.1).

Calculation of correlation coefficient(r)

Calculation of coefficient of correlation along with R square, adjusted R square and Standard Error of the estimate were presented in the Table 2. The determination coefficient (r^2) was used as an indicator of the quality of the linear regressions (Scherrer, 1984). In the present study the $r^2$was 0.95 that indicating a very good fit of model. The same

Table 1. *Descriptive Statistics (L-W) of A. mola*

Parameters	N	Minimum	Maximum	Mean	Std. Deviation	CV(%)
Length (mm)	910	20.00	87.00	56.85	10.30	551.66
Weight (g)	910	0.07	6.97	1.77	1.14	156.04

Table 2. *Model Summary*

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
	0.97[a]	0.95	0.95	0.07

a. Predictors: (Constant), LogL

Fig. 1. Sample Collection Site

Fig. 2. Haul of *A. mola*

result was reported from Padma River, Bangladesh (Hossain, 2010). In the present study the value of 'r' was found to be 0.97[a] which was already presented in the Table 2 showing a high degree of correlation between the two parameters. This test showed a highly significant value.That justified the fact that there was a strong significant relationship between length and weight.

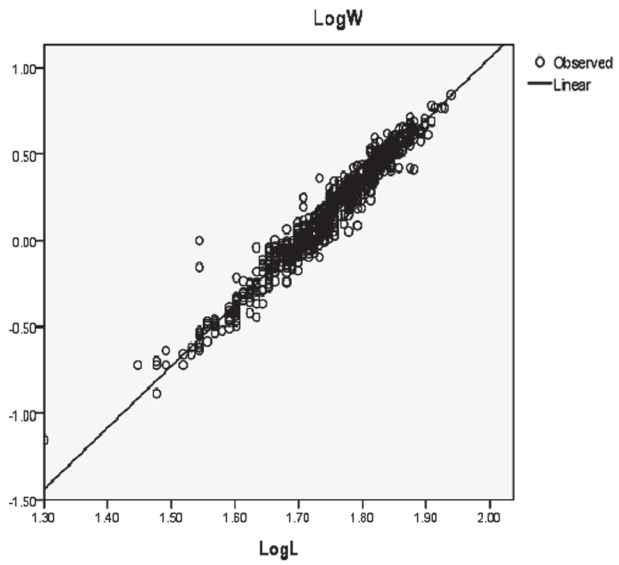

Fig. 3. Length-Weight Relationship of A. mola

Calculation of regression coefficient (b) and testing for significance

SPSS output for estimation and testing the significance of regression (ANOVA) was presented in Table 3. The significant of calculated regression was tested through ANOVA which was represented in Table 4. From the Table 4 we found that this regression co-efficient (b) was highly significant. In this case 'a' was found to be 6.08 and 'b' was 3.57 (Table 4). In the present study 'b' value (b=3.57) was more than 3 which was within the limits 2.5-3.5 for most fishes (Froese, 2006). The present study indicated positive allometric growth of *A. mola*. The same positive allometric growth of *A. mola* was also reported from Assam (Baishya *et al.,* 2010) and from Padma River, Bangladesh (Hossain, 2010). The positive allometric growth in *A. mola* (a= 0.0055, b= 3.397) of

Table 3. *ANOVA[b]*

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	78.59	1	78.59	1.712E4	0.000[a]
Residual	4.17	908	0.005		
Total	82.76	909			

a. Predictors: Constant, LogL b. Dependent Variable: LogW

Table 4. *Testing of constant and regression coefficient[a]*

Model	Unstandardized Coefficients		Standardized Coefficients Beta	t	Sig.
	B	Std. Error			
Constant	-6.08	0.05	–	-127.46	0.000
LogL	3.57	0.03	0.97	130.85	0.000

a. Dependent Variable: LogW

combined sexes was also recorded in the Mathabhanga River, South-western Bangladesh (Hossain *et al.,* 2006). Further in the present study 'b' was found to be highly significant as evidenced from 't' test presented in that Table 4. Here the calculated value of 't' is found to be 130.85 which is much higher from the tabulated value of 't' justifying that the regression co-efficient calculated based on L-W data of *A. mola* is significant. Now established between L-W relationship based on imperial data as Log W= -6.08 + 3.57 Log L. The exponential value of 3.57 was tested against '3' showed in Table 4 and was found to be significantly different (t = 130.85) at 1% level. In the present study the logarithm relationship between the total length and weight of *A. mola* directs towards strong positive correlation (r^2=0.95). The mean values of condition factor were calculated as 0.85 indicating extremely poor and thin body condition of fish. The reason may be due to insufficiency of the availability of preferred food of *A. mola* from where the species was caught. The result of the study will be useful for future researchers and policy planners and also helpful for the fishery managers to implement adequate adaptation-centric regulation for sustainable fishery management.

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Development of Information System for Evaluating Ground Water Quality in an Urban City of Eastern India

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Ground water is the major source of water supply in urban India. Understanding and assessment of groundwater quality for drinking and irrigation uses is therefore imperative to maintain its quality in any fast growing city like Bhubaneswar in Eastern India. A framework was developed in Visual Basic 6.0 software to generate quantifiable estimation of water use for drinking as well as irrigation purpose using different water quality parameters. Different forms have been prepared for water quality assessment and showing standard values for water quality parameters. Twenty different water quality parameters for drinking and nineteen water quality parameters for irrigation purposes were analyzed using 55 water samples of the study region. The total weightage of water quality parameters were analyzed in this software module. Different forms were created for entering the water quality parameters for evaluation. Formats have also been prepared for depicting desirable limits of different water quality parameters for indented purposes. This software module can be used as a ready-made package for assessing characteristic of water quality parameters for drinking as well as irrigation purposes.

***(Key words**: Information system, Water quality, Drinking and irrigation)*

Groundwater is the most preferred source of water for various users on account of its easy availability, dependability and low investment. The demand on groundwater has increased numerously in recent years. Supplying relatively good quality water, groundwater fulfills 50 percent demand of urban and industrial sectors (Ghosh and Sharma, 2006). Groundwater is annually replenished primarily through the rainfall & subsequently by surface water bodies such as rivers, lakes, tanks etc. At the same time, groundwater quality in some region got deteriorated due to seepage from industrial discharge, leakage of septic tanks/ sewerage system and soak pits has reported from several places. This increasing level of groundwater pollution particularly in urban areas is a matter of serious concern of Central Groundwater Board (CGWB, 2010).

Groundwater quality parameters are determined by many factors such as interaction of water with aquifer materials, influence of anthropogenic activities, evaporation, precipitation and other climatic variables. Being an important water source for drinking as well as irrigation, the quality of groundwater must be carefully managed within the standards recommended by Indian Statistical Standards Institution (ISI, 1991) and World Health Organization (WHO, 2004). In order to assess and sustain the quality of groundwater, it becomes essential to know its chemical character by measuring relevant parameters for its use in intending purpose. Irrigated production system contributes to more than 50% of the net production that needs to be maintained to meet the ever increasing demand of the burgeoning population in India. Water quality appraisal and assessment is a subject of discussion presently under agricultural irrigation. Water quality fluctuates with temperature, evaporation, amount of rainfall received at a particular period, anthropogenic involvement and the type of resources. Monitoring water quality at regular intervals is tiresome but crucial to ensure the quality of produce, and the soil and water quality in continuum. Understanding the character of water, identify the indicating parameters along with extracting information as much as possible from the water quality data set is the key to monitor water quality with ease and precise manner (Das *et al.*, 2010).

A precise assessment of quality of groundwater resource is a pre-requisite for long term planning and development in that region. The Ground Water Information System is a web based information system contains water level data and water quality data for the different States of the country developed by Central Ground Water Board (GWIS, 2013). An

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information system has been developed by Drinking Water Quality Regulator for Scotland for testing and monitoring of water quality parameters. Among 51 different water quality parameters, the ten most important parameters were analyzed for drinking purposes in Scotland (DWQR, 2013). Bhubaneswar the capital city of Odisha in eastern India is rapidly progressing by widening road, augmenting connectivity, developing various institutions, hospitals, complexes which eventually intensifies the activities per unit land mass and enhances the susceptibility of underground aquifer to get contaminated by diverse sources. The purpose of the study was to recognize the quality of groundwater and scale down the information to the level to identify key parameters for managing water quality for drinking and irrigation use in a fast growing city.

MATERIALS AND METHODS

Information systems and software are a key technology in this era of Information revolution in which the data is processed to get desired information and its dissemination to the end user as well as for decision making. Bhubaneswar, the capital city of Odisha was the study area, is situated between 20°12′ to 20°25′N latitude and 85°44′ to 85°45′E longitudes with an altitude of 40 – 45m above mean sea level (msl) which receives annual rainfall of 120 – 140 cm (average) during June to September with humid warm climate. Fifty five water samples covering 135 sq km area both from open dug wells and bore wells were collected in the month of April 2011 during pre-monsoon period for analysis. The mainly used of these water resources are for drinking, cleaning, preparing meals, washing and other domestic purposes. Even though the State Odisha, is blessed with average annual rainfall of 1482 mm groundwater is also a major contributor towards agricultural activities. The hydro-geological situations are quite conducive for steady replenishment of groundwater. Considering the high potential of groundwater development, Government has been encouraging groundwater exploitation by announcing popular subsidy schemes in the specific regions. But while developing groundwater structures for irrigation use, it is necessary to ensure its sustainable use in long-term basis.

Different forms have been prepared for water quality assessment and showing standard values for water quality parameters. Twenty different water quality parameters for drinking and nineteen water quality parameters for irrigation purposes were analyzed using 55 water samples of the study region. The marks were allotted to each water quality variable based on the seriousness of the impact in terms of its effect on crop growth, soil fertility and adjacent environment. Assigning a point value to each parameter, the variables were weighed on a ten-point scale and the percentage of acquired scores thus reflects the suitability of water for particular use. The total weightage of all water quality parameters were calculated in this software.

Microsoft Visual Basic 6.0 software was used in developing the front end formats in the software module. The information system was designed in such a way that it can be easily installable and effective operational under Microsoft Windows environments (Nayak *et al.*, 2013). Forms included text boxes, command buttons, combo boxes were designed for easy access in the system. The storage and retrieval of the data was mainly based on a software programme that supports the processing of large data quantities and the results were presented as per user's requirement.

RESULTS AND DISCUSSION

A framework was developed to generate information on water quality, process and downscale the water quality data for its rational utilization in intending purpose. Information generated on groundwater quality first figured out through hydro chemical facies identification, scaled down to form similar classes using hierarchical cluster analysis, unraveled the variability of discriminating variables through variance analysis to recognize them as

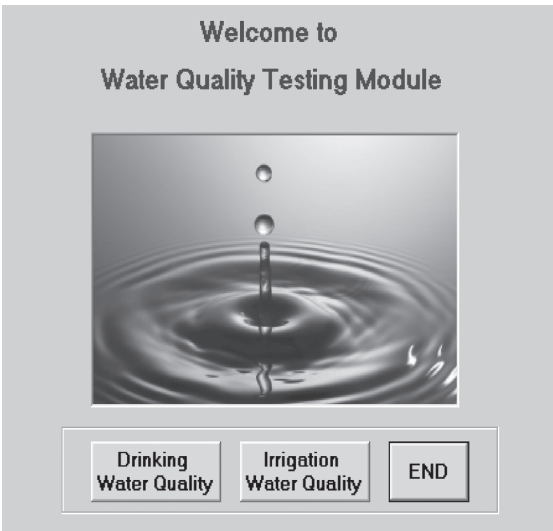

Fig. 1. Welcome window of the Software system

water quality indicators. Performing correlation and regression statistics the study again showed to estimate the indicating variables with least possible effort for periodical assessment of water quality parameters (Das, 2009).

The developed software system after installation automatically starts in a welcome window with title of the application appears with two options to enter in 'Drinking Water module' or 'Irrigation Water module' as shown in Fig.1. After selecting the drinking water module, another form opens with a list of 20 water quality parameters and option to enter the values of the parameters as described in Fig. 2.

The importance and weightage of each water quality parameters were assigned in this software module for calculation of the total usability of the water. The software system is designed in such a way that while entering the values of the water quality parameters in the text box, the color of the text box changes according to the values for desirable limits, permissible limits and unaccepted limit. The user can easily understand the range of that water quality parameter. After entering the values for the parameters, the user can click on the Calculate button to see the result and the percentage of usability of the water for drinking purposes as shown in Fig. 3. The system shows the outputs like 'The water is not usable', if any one of the three important water quality parameters like Floride, Nitrate or Ecoli is out of range. Another option is also created in the software module to see the standard values for water quality parameters.

While selecting for Irrigation water quality analysis module, a form opens with an option for

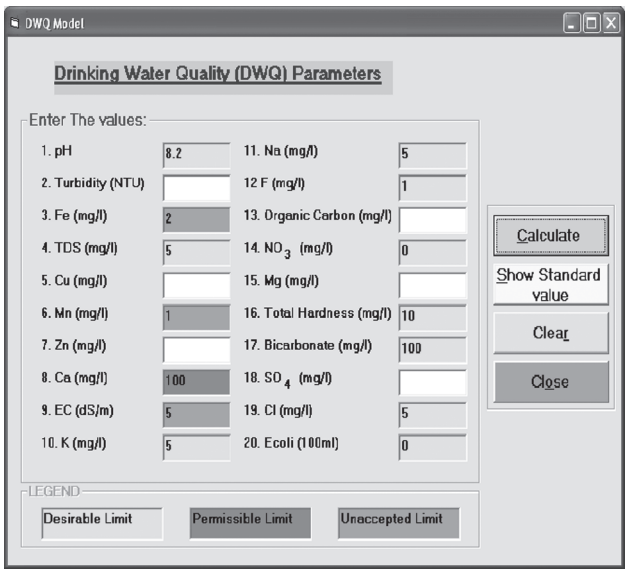

Fig. 2. Data format for entering drinking water quality parameters

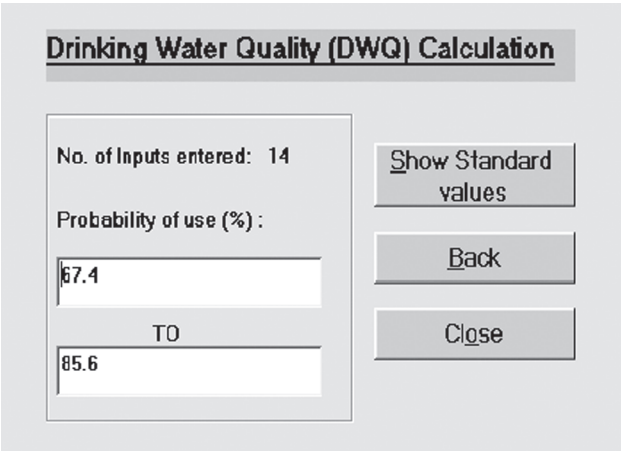

Fig. 3. Result module of the software system

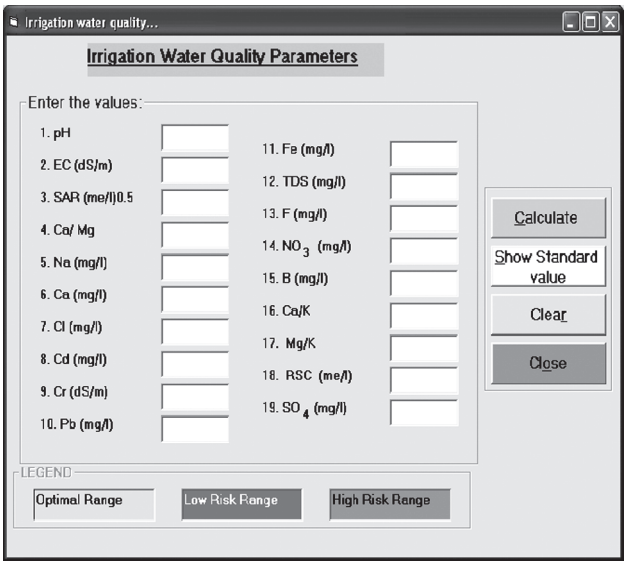

Fig. 4. Software module for testing Irrigation water quality

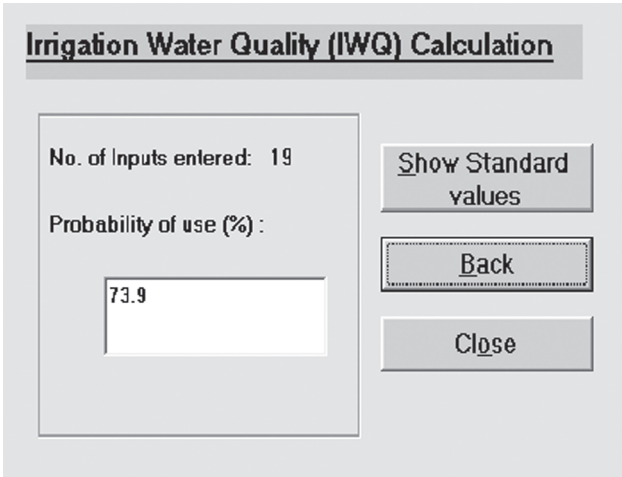

Fig. 5. Result module for irrigation water quality

While selecting for Irrigation water quality analysis module, a form opens with an option for

entering nineteen water quality parameters into the module as displayed in Fig. 4.

CONCLUSION

This information system developed based on the important water quality parameters for drinking as well as irrigation use. Sustainable development and efficient management of groundwater resources requires an effective information technology tool for the dissemination of information to different stakeholders. This will help to develop appropriate measures in improving the agricultural scenario of the region. This software module can be used as a ready made package for assessing characteristic of water quality parameters for drinking as well as irrigation purposes.

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Fisheries Management Practices in Coastal Karnataka: Fishers' Perception

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The opinions of the primary producers are very important for the development of fisheries management measures. In this study, Focus Group Discussion (FGD) method was considered to overcome this gap. It was observed that fishers agreed for banned season mainly because of sea safety and to reduce fishing pressure. They believed that mesh size regulation was not a useful method and it was not followed as it results in poor catch. It was felt that some of the fishers could be nominated by the group to carry out the agreed upon issues which could be monitored and encouraged by Department of Fisheries.

(***Key word:*** *Closed season, Mesh size regulation, Fishers' perception, Focus group discussion)*

Over the years, mechanization and modernization in Indian fisheries practices has led to intensification in the exploitation of the marine resources along the coast. Developments of scientific fisheries in India were initiated only after independence. With the introduction of Indo-Norwegian Project in early 1950's began the modernization in Indian fisheries resulted in improvement in fishing gears and crafts over the years. Mechanization process in India started only about 60 years ago, when India's First Five Year Plan aimed at increasing the fish production and developing technological and infrastructural facilities (Jayaraman, 1996). During 60's, major marine fish landings were by traditional fishing gears and few trawlers. The major development in fisheries was the introduction of Purse Seines during 1977 in the Karnataka, which led to increased landings of major pelagic resources all along the coast. Motorization of country crafts during 1980's and operation of multiday and high opening trawls during late 80's and early 90's resulted in heavy exploitation of both pelagic and demersal resources along the coast alarming over exploitation of major commercial important resources. Over the last 60 years, marine fish resources in India reached almost peak of its production (Dehadrai and Yadava, 2004). Most of the marine fishery resources were either fully exploited or over exploited during recent phases especially during 1990's and there is need for appropriate management measures to sustain the production (Shyam *et al.,* 2010). Recently Najmudeen and Sathiadhas (2008) estimated the economic loss due to juvenile fishing in India as Rs. 85,558 cores. To control increased fishing effort, management tools such as Maritime Zones of India (Regulation of Fishing by Foreign Vessels) Act 1981 and the Maritime Zones of India (Regulation of Fishing by Foreign Vessels) Rules 1982, Marine Fisheries Regulation Act and Code of Conduct for Responsible Fisheries at global level etc. were implemented throughout the coastal nation at different year period. Karnataka Marine Fishing (Regulation) Rule is one of the acts implemented in Karnataka during 1987 aimed at controlling the impact of fishery on the marine resources. There are different management measures that can be taken up like closed season (trawl ban/monsoon fishing ban) (introduced in Karnataka during 1989 (ICSF web source)) and mesh size regulation as important technical control measures for fisheries management (FAO, 1995). For the effective implementation of these management measures, it must be addressed through governments to those engaged in fisheries at the grass-roots level i.e. "Stakeholders in the fishery".

Therefore there is a need to understand the fishers' perception on the issues related to management of resources as they are the primary users of the resources, based on which the governments frame policy guidelines with the help of experts. This approach may increase the

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compliance level in the natural resource management. Against this backdrop, this study was conducted with the objective to assess the fishers' perception on two most important aspects of fisheries resources management, i.e., closed season (monsoon fishing ban) and mesh size regulation.

MATERIALS AND METHODS

The west coast of India, mainly coastal Karnataka was purposively selected for the present study to know about fishermen perception on closed season and mesh size regulation. Karnataka has three maritime districts namely Dakshina Kannada, Uttara Kannada and Udupi with a total coast length of 300 km. Three coastal villages were randomly selected in each of the districts which are Bengre, Mangalore Bunder and Sasihithlu from Dakshina Kannada; Padubidre, Malpe, and Kodikanyan from Udupi and Tadri, Belambar and Belikeri from Uttara Kannada district. In village, the fisher's societies were requested to participate in the Focus group discussion. Keeping in view the objectives set for the study; a semi structured schedule was developed for the focus group discussion. In each focus group discussion, 6-11 fishers participated and thus total of nine focus group discussions were carried out in nine villages. Perception and consensus of fishers' on closed season and mesh size regulations were summarized and appropriate measures were recommended for increasing the effectiveness of such fisheries management measures.

RESULTS AND DISCUSSION

Perception on closed season/ monsoon fishing ban

Table 1 shows current ban structure in Karnataka practised during monsoon season. According to the order, mechanized fishing between June 15 and August 10 must be banned in Dakshina Kannada and Udupi districts. The order from the government stated that the ban has been issued taking into consideration the condition of seas during monsoon season. This is for sea safety and conserving fisheries resources. However, deep sea trawlers, which can go to the sea from August 3, should return only at closing hours of August 10 in accordance with the ban period. In Uttara Kannada district, the ban will be in force for 47 days from June 15- July 31.The order has clarified that traditional boat, with or without outboard engines up to 10 hp, can undertake coastal fishing expeditions during the ban period. The order warned that those who violate the ban order would have to forfeit their share of subsidised diesel for a year and would be punished under the provision of the act.

All the fishers' groups of nine selected fishing villages were found to be aware of monsoon fishing ban and all were following the regulations. This may be because most of the fisher men felt that ban was helpful for their own safety and livelihood security. They were not aware of the exact year when the ban was implemented and according to them it was during 90's. However, all the fishers groups perceived that the rule of allowing only traditional boats (10 hp motorized engines) during ban period was violated by some fishers and motorized boats up to 30 hp are entering the sea.

According to fishers, some of the reasons for ban were 'safety measures', 'minimizing the fishing pressure' and 'breeding season'. Out of 9 groups, only 4 groups of fishers agreed that the ban was necessary for breeding of fish and remaining 5 groups did not agree with this mainly because fishes were observed to breed in other months of the year. Majority of the fishers said that they were getting smaller sized fishes during other months of the year, indicating fishes breed year round.

Some earlier research findings were also in concordance with this perception of fishers. According to Jose (1998) there was no scientific basis to say that monsoon period is the breeding season of fish as many fishes breed during November and December. Charles (2001) said that the ban is for safeguarding the spawning process of fishes. Meanwhile, discussion with experts regarding this issue concluded that fishes may breed throughout the year but majority of them breed

Table 1. *Fishing Ban structure of Karnataka*

District	Date	Duration
Dakshina Kannada	June 15- Agust 10 (Including both dates)	57 days
Udupi	June 15- Agust 10 (Including both dates)	57 days
Uttara Kannada	June 15- July 31 (Including both dates)	47 days

Source: Government of Karnataka office order dated: 30-07-2007.

during monsoon period. By considering fishers' safety and breeding season of most of the fishes, the monsoon period was kept as a closed season along the coast. Only few groups of fishers agreed that catch increased immediately after the ban period. According to the data, month wise average marine fish production of Karnataka for last 16 years depicted a high fish catch after August indicating increased catch immediately after ban period. Kurup (2007) reported that because of trawl ban, the marine fish production enhanced in first phase of ban period in Kerala.

The entire fishers' groups perceived that there should be uniform fishing ban required along the coast. We could observe the discrimination within the state that Dakshina Kannada and Udupi following 57 days ban and for Uttara Kannada it is 47 days (Table 1). Therefore, the uniform fishing ban along the coast would restrict everybody without any discrimination. According to De Groot (1984) and Bergman and Hup (1992) trawling is a destructive fishing method. Most of the fishers except trawlers believed that trawling was damaging the environment and few fishers felt that purse seine was also a destructive fishing method.

The fishers' groups also agreed that the marine fish catch had fluctuated over a period of time. According to Bhatta (2003) some of the reasons for decline in fish catch were increased fishing effort, pollution, destructive fishing practices and industries and development projects.

During the closed season, both fishermen and mechanized boat owners would have to mobilize other means of income. Only few fishers were getting financial or some other means of support from the government. Some worked in boat building or net mending yard and operated traditional boats during ban period. Some fishers who worked as crew in mechanized boats borrowed money from their owners during ban period.

Perception on mesh size regulation

The gear selectivity is one of the important tools in fisheries management practices mainly to avoid by-catch and to protect juveniles. So there is proper identification of mesh size for all fishes required and is very difficult in multispecies fisheries. However, the calculation of optimum mesh size for multispecies fishery requires huge data which are lacking in most of the cases (Sainsbury, 1984). According to mesh size regulation, the ideal mesh size for trawler is 35 millimeter (mm) (code end) and for purse seiner it was 20mm (Somashekar, 2007). All the fishers were aware of mesh size regulation and only one group said it is useful. Fishers did not comply with mesh size regulation because of poor catch with such regulation. According to Nielsen and Mathiesen (2003), mesh size regulation was very difficult to enforce and was not compatible with fishing practices and was likely to be bypassed by fishers. All the fishers groups were aware of optimum mesh size for both trawl and purse seine gear in mesh size regulation. Around 50 per cent of the respondents used trawl net of mesh size 10-14 mm (code end) and few used 12-18 mm mesh size. The average net size of purse seine ranged from 10-20 mm. The fishers believed that this was the ideal one. All the fishers groups perceived that the size of the fish had decreased over a period of time. They believed that pollution, increased number of boats and catching more brooders had led to decreased size of fish. As many commercially important resources of Karnataka are overfished (Mohamed *et al.,* 1998) there is a severe need for reduction in fishing pressure

According to fishers, controlling pollution, closed season and restrictions on number of boats were the suitable measures to avoid reduction in catch but not the mesh size regulation. They perceived that the fishing ground has changed over a period of time and it has moved away from the shore. According to them the major reason for change in the fishing ground was pollution. There were least concern for by-catch and no measures were taken to reduce it. Usually the by-catch will be sold to fish meal industry and some time discarded into the sea. On the income profile of fishers over a period of time, it was fluctuating and sometimes difficult to manage family. Depending upon the catch, the income was divided between the crew members and owner. However, fishers usually get smaller sized fishes during January, April and May and bigger sized fishes during September, October, November and March and accordingly the income varies. They perceived that increase in number of boats was the major reason for fluctuating income.

Recommendations

1. ***Uniform banned season***

   Fishers were observed to be aware of monsoon fishing ban. However, they did not agree that it would increase fish production as breeding season does not coincide with ban season. Therefore, ban should only be linked with

roughness of sea during monsoon season and not with breeding season of the fish. This will help in taking a uniform ban season for entire region.

2. ***Alternative sources of income***

   The income from fishers is insufficient to ensure livelihood security. Therefore there is need to generate alternative livelihood opportunities by organizing different training programmes on mariculture, ornamental fisheries, fish processing, and through MNREGA (Mahatma Gandhi National Rural Employment Guarantee Act) etc.

3. Self Help Groups (SHG) of fisherwomen should be formed, where some amount has to be saved in each month in SHG account and it should be used during closed season.

4. Controlling pollution: Fishers have categorically identified that pollution and increased number of boats has reduced the catch per boat. Department of Fisheries, Pollution Control Boards, Media and Community Organizations of fishers should form a Joint Water Pollution Management Committee to bring awareness about the water pollution.

5. Open discussion with fishers

6. In this paper a FGD approach has been evolved to enhance the free and open-minded participation of such primary stakeholders. Through such participation, it was observed that there lies a disparity in the perception about the outcome of such regulation between the department of fisheries and the fishers. Therefore, in order to increase their participation in conservation measures, mesh size regulations, closed season, restriction of boats and pollution etc. the action plans need to be developed only after discussing the pros and cons with the fishers. Action plans to create awareness and build consensus among the fishers group;

   - Identification of fishers' groups agreeing to ban season and restriction of number of boats as core group.
   - Conducting separate workshops with the above identified fishers on future action plan for fixing ban season and for restricting the number of boats.
   - Creating awareness, holding open discussions and harnessing consensuses with other fishers about ban season and number of boats to be restricted with the help of above group.

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J. Indian Soc. Coastal agric. Res. 32(1): 68-69 (2014) **Short Communication**

Genetic Variability and Correlation Analysis for Yield and Grain Quality Characters of Rice (*Oryza sativa* L.) Grown in Coastal Saline Soils of Goa

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Soil salinity is one of the major abiotic stresses affecting the yield of rice crop in the coastal regions of the country. In India, of the total 8.5 M ha of land which is affected with soil salinity, about 2.10 M ha are coastal saline and the yield reduction is estimated to be around 30-50%. In Goa, rice is the principal food crop accounting for more than 39% of the total cultivated area in the State. The State has 18,000 ha of land affected with coastal salinity of which more than 12.000 ha of land are under rice cultivation. The pH of these soils is slightly acidic to neutral (6.0-7.0) with electrical conductivity 4 to 15 dSm^{-1}. Rice varieties grown in these areas are mostly landraces and the productivity of these landraces are very low due to multiple stresses *viz.*, salinity, partial and complete submergence and water logging situations occurring in these soils during the crop growth. There is a need for development of rice varieties with improved productivity, quality and tolerance to multiple abiotic stresses prevailing in these areas. Enriching germplasm resources and to understand the magnitude of variability and association of various agro-morphological characters with grain yield is a prerequisite for initiating any breeding programme. Hence, in this study, genetic variability and character association were studied for yield and grain quality characters in rice germplasm under coastal salinity situation.

The experimental material consisted of 31 diverse rice genotypes comprising landraces, advanced breeding lines and improved cultivars. The experiment was laid out in randomized block design with three replications in farmer's field (15° 33′ N latitude, 73° 53′ E longitude and +3.0 m MSL) under natural coastal salinity situation at Chorao Island, North Goa during the wet season 2011-12. The pH of the soil ranging from 5.46 – 6.00 and EC from 2.98 to 7.51 dSm^{-1}. Twenty one day old seedlings were transplanted with spacing of 20 cm X 15 cm and each genotype was grown in seven rows of 2.5 m length. Observations on yield, yield components and quality parameters were recorded for each of the genotype in each replication. The variability was estimated as per procedure for analysis of variance suggested by Panse and Sukhatme (1985), GCV and PCV by Burton and De Vane (1953) and heritability and genetic advance by Johnson *et al.*, (1955). Correlation coefficient was worked as per Al-Jibouri *et al.*, (1958).

The analysis of variance revealed significant differences among the genotypes for all the characters studied. Close relationship between GCV and PCV was found in all the characters and PCV values were slightly greater than GCV, revealing very little influence of environment for their expression. Heritability > 80% was observed for almost all the characters except productive tillers per hill (76.59%), grains per panicle (58.56%) and per cent fertility (31.64%). High heritability in broad sense and high genetic advance as per cent mean was observed for characters *viz.*, straw yield, grain yield, harvest index, test weight and L/B ratio. Correlation study indicated that, characters *viz.*, harvest index, followed by panicle length, grains per panicle and L/B ratio exhibited significant positive correlation with grain yield both at genotypic and phenotypic level.

The characters governed by high heritability with high genetic advance as per cent mean were controlled by additive genes action and these characters may enhance the grain yield through selection. Based on the correlation analysis, it may be concluded that harvest index, panicle length and grains per panicle appeared to be primary yield contributing characters and could be relied upon for selection of genotypes to improve genetic yield potential of rice.

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J. Indian Soc. Coastal agric. Res. 32(1): 70-72 (2014) **Short communication**

Impact of Brackishwater Shrimp Culture on Natural Resources – a Case Study in Coastal Odisha

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Brackishwater shrimp aquaculture is a favorable and lucrative livelihood option for farmers in coastal area. The practice is reported to produce unfavorable impact on the coastal environment. Discharge of shrimp wastes degrade the quality of local water bodies, seepage loss of saline water from shrimp farm ponds increases salt level of soil and water resulting to low yield of rice as reported by several rice farmers in coastal area. Nonetheless, by exporting brackishwater shrimp India earned handsome amount of foreign exchange @ 16.67% growth rate from 1997 to 2000. It is an emerging export driven production system, generating income, creating employment opportunities and thereby provides a livelihood security for rural communities. The practice is therefore expanding exponentially and encroaching the rice cultivated land in coastal areas. Some of the issues pose concerns are location specific, as in Odisha the coastal flat land serves the 'rice basket' of the state, it is the gift of three rivers. Impact of the practice is not friendly with soil and water qualities in rice field area. It is a remunerative farming option. Regulating the farming to produce minimum possible impact on soil and water qualities is thus required to restore the quality of coastal ecosystem. The purpose of the investigation was take a stock of soil and water qualities appraisal and study the extent of impact of brackishwater shrimp farming in coastal area

The coastal plains of Odisha stretch on the eastern coast of India from the Subarnarekha in the north-east to the Rushikulya in the south-west. This fertile region is known as the 'rice bowl' of Odisha. This is narrow in the north, widest in the middle, narrowest in the Chilika coast and wide in the south. For establishing information on soil and water qualities, both the soil and water samples were collected from shrimp farming practice area all along the coastal tract while to study the extent of shrimp farming practice on soil and water, the study area was selected at Erasama, and at Astaranga, on the basis of type of shrimp farming practice in coastal Odisha. Soil samples were collected from the area in and around the brackishwater shrimp farming pond, and water samples from shrimp pond (brackishwater), rain water harvesting ponds, open well tube well as per the recommendation made by APHA (1995). All the samples were collected during pre-monsoon, monsoon and post-monsoon periods from 2008 to 2010, and analyzed.

Coastal area is characterized by soil and water salinities, which vary with seasons and also over space. Magnitude of salt stress occurred in soil and water depends on soil type, lithology, relief and local climate, fluctuates with seasons and the amount of rainfall received during the period of study. Owing to that distinguish between salinity build up through brackishwater aquaculture practice and seasonal influence is difficult in coastal area. However, for proper utilization of soil and water sources the coastal regulatory authority has established the norm for practicing aquaculture along with the optimum stocking density in various shrimp farming practices, listed below:

Stocking Density	**Type of practice**
40000 – 60000 ha^{-1}	Traditional/ Improved traditional
60000 – 1000000 ha^{-1}	Scientific extensive system

Applying this to coastal shrimp farming practicing area in Odisha, Astarang and Erasama blocks representing "Traditional/Improved traditional" and "Scientific extensive system" were selected for this study.

Appraisal of soil and water qualities across the shrimp farming area

Soil properties relevant to soil fertility have been observed to vary across the different shrimp farming area. Data pertaining to relevant soil characteristics (Table 1) reveal that soil was invariably acidic in reaction with different salt stresses. Preponderance of Na over Mg and Ca in soil exchange complex was also maintained as obtained in water sources contained different amount of organic carbon, phosphorous, and other nutrient cations but the

Table 1. *Important soil properties (SEm)*

Soil parameters	Kendrapada / Mahakalpada	Ersama	Bhadrak / Baleswar
pH	4.49 + 0.58	5.33 + 0.41	5.17 + 0.41
EC_2 (dS m^{-1})	2.2 + 0.6	3.9 + 0.6	2.6 + 0.7
Organic carbon (%)	0.77 + 0.27	0.54 + 0.12	0.43 + 0.06
Bray's - P (mg kg^{-1})	0.95 + 0.11	1.13 + 0.08	0.97 + 0.1
Exchangeable K (mg kg^{-1})	575.73 + 191.16	595.4 + 180.56	447.07 + 81.54
Exchangeable Ca (mg kg^{-1})	911.97 + 166.45	496.94 + 163.07	975.66 + 112.46
Exchangeable Mg (mg kg^{-1})	1373.4 + 337.26	1180.47 + 306.63	1325.44 + 140.46
Exchangeable Na (mg kg^{-1})	2529.75 + 844.35	4617.0 + 1383.7	2720.83 + 640.82

Table 2. *Relevant water quality characteristics at pre – farming period in brackish water shrimp farm area in coastal Odisha (SEm)*

Water quality attributes	Dhamra	Kendrapada	Baleswar	Ersama	Overall
pH	6.8 + 0.35	6.57 + 0.19	6.6 + 0.22	6.34 + 0.67	6.57 + 0.22
EC (dS m^{-1})	3.38 + 1.12	4.32 + 0.79	5.9 + 0.21	5.25 + 1.07	5.59 + 0.3
Na (mg l^{-1})	1919.91 + 725.8	1961.77 + 596.51	2467.83 + 332.26	2485.28 + 894.17	2209.57 + 341.87
K (mg l^{-1})	96.6 + 35.76	115.14 + 22.26	122.72 + 19.85	136.8 + 46.43	118.52 + 16.97
Ca (mg l^{-1})	138.88 + 30.1	148.17 + 22.98	216.28 + 34.09	238.78 + 69.26	186.65 + 24.34
Mg (mg l^{-1})	333.96 + 137.51	314.14 + 88.34	469.41 + 132.4	482.86 + 113.28	400.76 + 57.33

estimates varied across the places. Water at pre farming (shrimp) stage was found to vary from strongly acidic (pH 3.66) to alkaline (pH 8.45) in reaction, and highly saline (Table 2). It was Na – Mg – Ca type where Na preceded by 5 – 6 times over Mg and 11 – 13 times over Ca while Mg was headed by 2 to 2.5 times over Ca.

Water quality across the sources

The water quality changes with type of water sources, fluctuates with seasons and varies over space in coastal Odisha. Data pertaining to relevant water quality parameters in Fig. 1 reflect an increasing trend of salinity across the sources from monsoon to summer periods. It was almost at par in river/canal/drain water with brackishwater shrimp pond followed by paddy field – water, rainwater harvesting pond and groundwater. The groundwater was not much constrained by the rising of salt stress while it was 11 to 188 and 55 to 92% in paddy field and pond water. The Na, Ca and Mg stress was also intensified over time with a highest value registered as. 1.11 to 2.45 times for Na, 0.39 to 3.78 for Ca and 0.33 to 2.32 times for Mg in shrimp pond water. Frequent water exchange during the practice in the pond may result in high salt load and its constituents in the water. This consequently indicates about high salt load on soil and water resources in paddy growing area in coastal Orissa

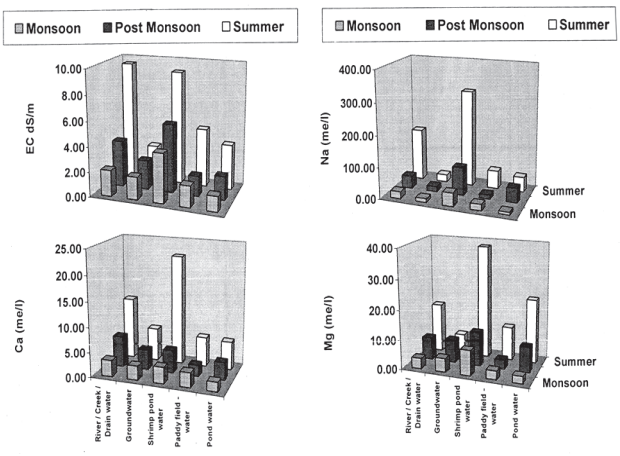

Fig. 1. Distribution of salt stress and major cations across the water sources and with time-periods in brackish water shrimp farming area

Soil Properties

Soil texture plays key role to control salinity development in soil profile, therefore to know the salt stress retained from brackishwater inundation was studied in the laboratory. The soil texture varied from sandy loam (sl) to clay (c) with percentage content of 21.46 to 85% sand, 2.5 to 28.62% silt and 5 to 57% clay while the "(Silt+clay)/sand" ratio ranged 0.18 to 0.84.This account for developing 0.18 to 6.33 times more salinity in soil, Linear or near linear increment of salinity can be easily controlled by draining the excess salt through leaching by low-

saline water, as observed in the light textured soil (sl to scl) having high sand content (54.4 to 85%). Under sub-humid climatic condition, this can be naturally controlled by the monsoon-rainfall. But quadratic rise of salinity can not be controlled by leaching with low-saline water and thus probability of persistent salt build up in brackishwater shrimp farming in paddy cultivated area can not be ruled out.

Extent of salt load due to brackish water shrimp farming in cultivated pasture

The shrimp farming season varies from March/ April to June in Astrang and Ersama area while throughout the year in Balasore and Bhadrak district of coastal area. It has also been practiced from August to November in some places at Astarang and Erasama. On an average 7 to 8 dS m^{-1} of EC is used to maintain in this standing water of the shrimp pond of 4000 m^2 size. That equivalent to to17922 to 20480 ton salt per brackishwater shrimp pond area. On the basis of amount of soil this practice exerts a pressure of salt grows to the tune of 22.4 to 25.6 ton salt per Kg soil for 120 days.

Inferences

Brackishwater shrimp culture is a promising livelihood option for small and marginal farmers in coastal Odisha. The practice is not incompatible with the environment in the locations which are persistently saline and usually not used for agricultural crops. Coastal salinity fluctuates with seasons and creates a harmony with nature, but the practice induces an unusual salt stress to the tune of 2.3 to 7 times more salinity (ECe) than the salinity observed in low lying paddy growing area, which is strikingly varied with soil texture, specifically relative presence of soil mechanical separates. It has been found that continuous stagnation of saline water of 7 – 8 dS m^{-1} magnified the salt stress in soil and didn't discharge the excess salt content even after prolonged rainfall. A sustained salt build up e.g. 6.1 dS m^{-1} (ECe) was observed in the soil, which was initially non saline. Rise of salt concentration slowly enriches Na concentration in soil exchange complex, raised exchangeable sodium percentage and deteriorate soil structure. This has been marked by loss of saturated hydraulic conductivity of soil. Increase of soil salinity also poses potential threat to raise salt stress in underground aquifer and making them unusable in farming. Without proper measures of soil and water conservation the study thus reflects that brackishwater shrimp farming slowly degrade soil and water qualities in coastal paddy growing area in Orissa.

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J. Indian Soc. Coastal agric. Res. 32(1): 73-74 (2014) **Short communication**

Performance of Sweet Potato (*Ipomea batatas* L.) Varieties under North Konkan Conditions of Maharashtra

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An experiment was conducted at two locations, viz. at Palghar and Dhansar to evaluate the performance of different sweet potato varieties viz. 362 – 7, SV – 98, CIPSWA – 2, Kamal Sundari and Konkan Ashwini (Check). There was significant difference in the yield. The maximum yield (20.722 t ha^{-1}) was recorded by the variety Kamal Sundari followed by Konkan Ashwini (18.741 t ha^{-1}). The infestation of sweet potato weevil was also maximum in the orange fleshed sweet potato as compared to check (Konkan Ashwini). The maximum average organoleptic score (8.66) was reported by variety Kamal Sundari and Konkan Ashwini.

Sweet potato (*Ipomea batatas* L.) a 'Poor man's crop' is one of the world's highest yielding crop and is grown over a wide range of environmental conditions throughout the world. It has capacity to produce the highest amount of calories per unit area and time as compared to cereals and other root and tuber crops. Among the tuber crops, it ranks third in terms of its contribution to agricultural economy in India. In the recent years, it is being recognized as a crop with potential for high productivity and energy output (Haldavnekar *et al.*, 2009). It has capacity to produce the highest amount of calories per unit area and time as compared to cereals and other root and tuber crops. In 2009-10, the area under sweet potato cultivation in India was 1.19 lakh ha with production of 10.95 lakh MT and the productivity was 9.205 Mt ha^{-1}. There is a demand for sweet potato and lack of tuber storage facilities. The sweet potato weevil is the most serious and ubiquitous pest of sweet potato (Palaniswami and Chattopadhya, 2005) which causes yield loss indirectly by damaging the vines especially at the collar region. The pest is associated with the crop wherever it is grown and can breed and multiply throughout the year. It makes tubers unsuitable for consumption.

There is genetic diversity in the sweet potato and the demand is more to red coloured tubers than white coloured tubers. It might vary from locality to locality. In the recent years, the orange fleshed varieties were developed. As there is increasing and year round demand of sweet potato, systematic researches on all aspects are essential. Considering its huge potential in Konkan region for its cultivation, the present investigation was carried out to evaluate the performance of different orange fleshed sweet potato types under north Konkan conditions of Maharashtra state. The multi locational trial was conducted at two locations, one at Palghar and another at Dhansar in Thane district.

Five varieties of sweet potato viz. 362 – 7, SV – 98, CIPSWA – 2, Kamal Sundari and Konkan Ashwini (Check) were selected for study. The experiment was conducted in two sets as multi-locational trial, one at Palghar and other at Dhansar village, Dist. Thane during *Rabi* season of 2010-11. The experimental sites have black fertile soil with pH 8.2. The experiment was laid out in Randomized Block Design with four replications. The recommended preparatory tillage operations were followed. As per the recommendation, basal dose of 30 kg N, 60 kg P_2O_5 and 60 kg K_2O along with 25 t FYM ha^{-1} were applied at the time of land preparation. The ridges and furrows were made at the spacing of 60 cm and healthy 3 to 4 node cuttings from top and middle portion of vine were planted at 20 cm spacing on each ridge. Total 250 cuttings of each variety were planted in each replication. The same set was replicated at another location. The remaining 60 kg N was given in two split doses as top dressing at one and two months after planting. All recommended intercultural practices were followed. The yield of each variety was recorded and the infestation of sweet potato weevil was also recorded. The organoleptic qualities in terms of colour and appearance, flavour and taste were assessed by panel of 10 judges with 9 point Hedonic scale score (Amerine and Singletone, 1972). The data were statistically analyzed by the method suggested by Panse and Sukhatme (1985).

Table 1. *Yield performance of orange fleshed sweet potato varieties under north konkan coastal zone*

Sr. No.	Variety	Yield (kg/250 vines)		Yield (t ha^{-1})			Infestation of sweet potato weevil (%)
		VIS Farm	Farmers field	VIS Farm	Farmers field	Mean	
1.	362 - 7	52.50	52.50	16.800	16.800	16.800	20.00
2.	SV – 98	51.23	53.63	16.394	17.162	16.778	23.50
3.	CIPSWA – 2	45.06	50.75	14.419	16.240	15.330	18.00
4.	Kamal Sundari	64.76	64.75	20.723	20.720	20.722	13.50
5.	Konkan Ashwini	59.63	57.50	19.082	18.400	18.741	5.50
	SEm +	1.49	2.49	0.48	0.80	0.64	1.05
	CD at 5%	4.60	7.68	1.43	2.39	1.91	3.25

The yield data both at Palghar and Dhansar locations in North Konkan region of Maharashtra are presented in Table 1. It is revealed from the data, that there was significant difference in the yield of orange fleshed sweet potato. The significantly maximum yield (20.722 t ha^{-1}) was recorded by the variety Kamal Sundari followed by check, Konkan Ashwini (18.741 t ha^{-1}). The infestation of sweet potato weevil was also maximum in the orange fleshed sweet potato as compared to check (Konkan Ashwini). Many workers such as Singh and Mishra (1975), Lokhande (2003) reported similar kind of results during their investiugations in sweet potato.

The organoleptic scores recorded by the panel of judges are given in the Table 2. It is revealed from the Table 2, that there was no significant difference in the organoleptic score in terms of colour, texture and flavour. The maximum average organoleptic score (8.66) was reported by Kamal Sundari and Konkan Ashwini.

Table 2. *Organoleptic evaluation of sweet potato types*

Sr. No.	Variety	Organoleptic score			Average score
		Colour	Texture	Flavour	
1.	362 - 7	7.5	8.5	8.0	8.33
2.	SV – 98	7.5	8.0	8.5	8.00
3.	CIPSWA – 2	7.5	8.5	8.0	8.00
4.	Kamal Sundari	8.5	8.5	9.0	8.66
5.	Konkan Ashwini	9.0	8.5	8.5	8.66
	SEm +	0.30	0.23	0.22	
	CD at 5%	N.S.	N.S.	N.S.	

Considering the high yield and comparatively less infestation of sweet potato weevil, and preferably high acceptance the orange fleshed sweet potato variety Kamal Sundari has high potential for cultivation in north Konkan coastal zone of Maharashtra.

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