

Strawponics for successful garlic

(*Allium sativum* L.) cultivation in coastal saline soils

Sukanta K Sarangi¹, S Raut², K K Mahanta³ and U K Mandal⁴

ICAR-Central Soil Salinity Research Institute, Regional Research Station, Canning Town,
South 24 Parganas, West Bengal 743 329

Monocropped coastal salt affected lands of Gujarat (0.46 mha), West Bengal (0.44 mha) and Odisha (0.15 mha) could be brought under garlic cultivation by adoption of strawponics through zero tillage planting and use of paddy straw available plentifully in this region. Straw is used as a medium of growth for garlic bulbs instead of soil. In this technology, zero tillage planting enables earlier establishment of garlic crop with efficient utilization of carry over soil moisture from previous kharif season and paddy straw cover helps in conservation of soil moisture and restricting the soil salinity development. Optimum crop geometry should be followed for proper growth of garlic bulbs. This package of practices along with integrated nutrient management can help to grow garlic with yield of more than 6 t/ha in coastal saline soils.

Keywords: Coastal salinity, Economics, Garlic, Strawponics, Zero tillage planting

GARLIC (*Allium sativum* L.) is one of the most important commercial bulb crops of India due to its consumption requirement as spice or condiment, medicinal value as well as export potential. The major producing States are Madhya Pradesh, Rajasthan, Uttar Pradesh, Punjab, Gujarat, Assam, Odisha, West Bengal and Karnataka accounting for 95% of area (Fig 1) and 97% of production (Fig 2). India earns through export of fresh as well as chilled garlic, dried garlic, dehydrated garlic powder, dehydrated garlic flakes and garlic oil. Export of garlic and garlic products resulted in ₹ 149.45 crores of forex during 2015-16, however, this is only 2.2% of export of major vegetables. Globally China is the leader in garlic area, production and productivity. India is far behind China in area and production of garlic. Raw garlic has an energy value of 623 KJ (149 kcal) per 100 g and is a rich source of carbohydrates (33%), proteins (6.4%) and fat (0.5%). It also contains phosphorus, potassium,

calcium, magnesium, volatile oil, helps in digestion of food and reduces blood cholesterol in human beings. Therefore, there are a lot of advantages for garlic cultivation and India needs to increase the production of garlic by employing advanced production technologies as well as by bringing more area under cultivation of garlic. There is very

meagre chance of increasing area by brining fertile land under cultivation. Fallow and degraded land which are hitherto not under cultivation may be an option for increasing the area. Since garlic is a cool season crop, it is suitable for growing during the *rabi* season after harvest of *kharif* rice. The rice fallow area of 9.6 million ha (mha) in eastern India may be tapped

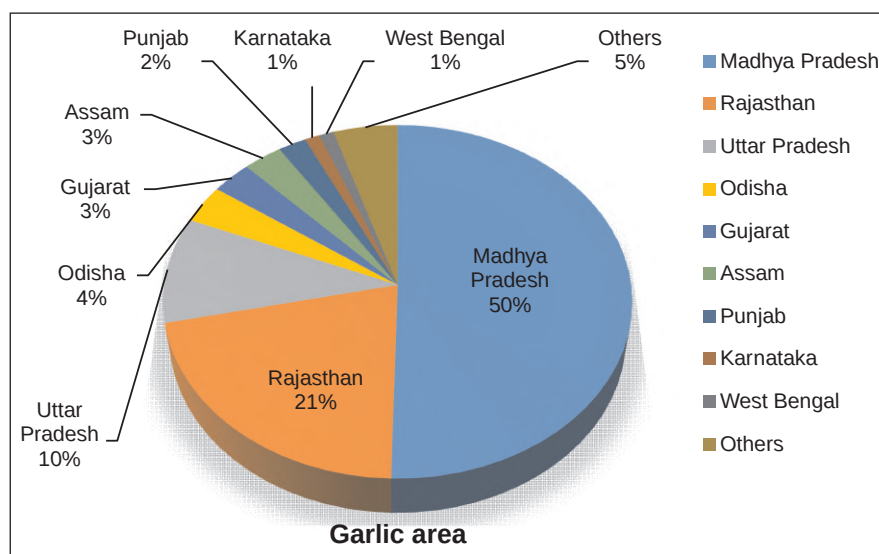


Fig. 1. Distribution of garlic cultivated area in different states of India

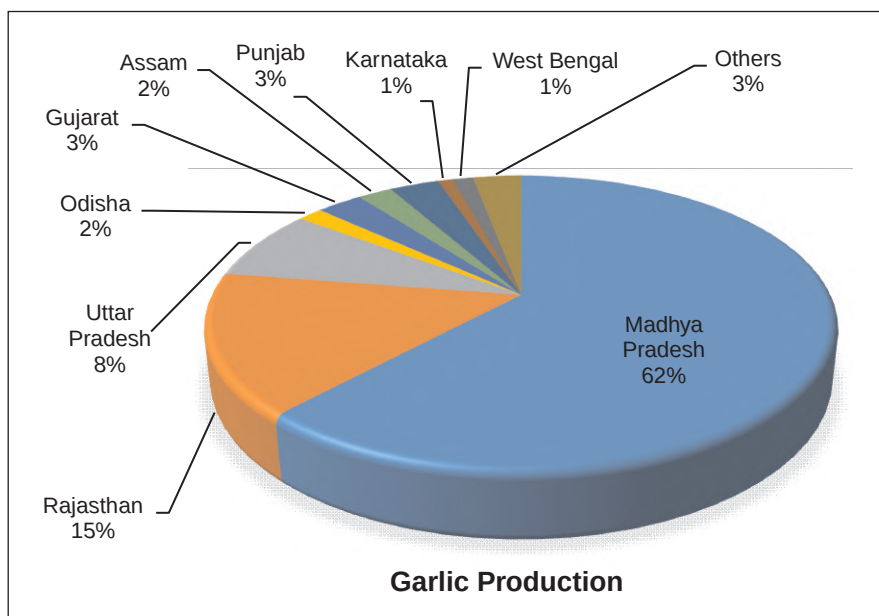


Fig. 2. Contribution of different states to garlic production in India

for cultivation of garlic. Particularly the coastal saline soils (1.25 mha) consisting of West Bengal (0.44 mha) and Odisha (0.15 mha) in eastern India and Gujarat (0.46 mha) in western India could be brought under cultivation of garlic, if suitable technologies are developed. Zero tillage planting with paddy straw mulching has been found to be an effective technology for growing *rabi* crops in coastal saline soils. To test the strawponic cultivation of garlic compared with conventional tillage intensive cultivation practices, an experiment was conducted at ICAR-Central Soil Salinity Research Institute (CSSRI), Regional Research Station, Canning Town during the *rabi* season of 2020-21 and to develop cultivation practices of garlic for coastal saline soils.

Strawponics garlic cultivation by zero tillage planting and paddy straw mulching

Conventional garlic cultivation in non-saline soils consist of intensive tillage operation of ploughing the land for 5-6 times. This tillage operation could be done when the soil moisture is at optimum range for use of tillage implements. However, in coastal saline soils, after the harvest of long duration rice crop, the soil remains wet and it takes time for drying of the soil. This delays the sowing time, as a result it is not

possible to cultivate crops which require winter season during its growth period. Keeping this fact in view, a study was conducted to find out alternative crop establishment methods for garlic crop in coastal saline soils. Since paddy is the major crop in the coastal region during the *kharif* season, there is ample production of straw from the tall varieties suitable for this waterlogged situation. This straw provides scope for strawponics during the following *rabi* season for growing high value crops. The present study consisted of (1) conventional tillage and planting of garlic without mulching (control) and strawponics cultivation method involving zero tillage (ZT) planting with 7 t/ha paddy straw cover and 30×10 cm spacing. The previous crop rice (var. Swarna-Sub 1) straw was used for strawponics as per the treatments. Planting under strawponics was done on 26 November 2020, just after harvest of *kharif* rice. For conventional tillage, ploughing was done three times by a power tiller followed by levelling and making ridge and furrow, these operations delayed the planting to 07 December 2020.

Selection of garlic cloves as seed and plating of cloves

Garlic is propagated asexually by planting cloves (the compound bulb of garlic consist of several small



Fig. 3. Planting of garlic cloves just after rice harvest



Fig. 4. Emergence of garlic shoots from paddy straw



Fig. 5. Paddy straw mulch suppresses weeds whereas there are weeds in conventional cultivation practice



Fig. 6. Manual weeding to remove the weeds from the crop during initial stages of garlic crop

bulblets or cloves) in soil (Fig 3). The cloves are separated from bulbs and then planted. Healthy and disease-free garlic cloves of 0.5 t/ha was used for planting. Larger size cloves were preferred for planting. The papery husks of each clove were kept intact before planting. In case of ZT planting, cloves were dibbled at 5.0 – 7.5 cm soil depth, in an upright position with root side facing down and pointed end facing up. Plant to plant spacing of 10 cm was maintained and row to row spacings of 20, 25 and 30 cm were tested. Garlic shoots emerged from the paddy straw cover without any effect on germination (Fig 4). Garlic is a fertilizer responsive crop, besides organic manures, balanced inorganic fertilizers application is required to obtain higher yield. Fertilizer dose of 75-40-40-20 kg NPKS + 5 t farm yard manure (FYM) per hectare was used uniformly for all the treatments. FYM was used to cover the cloves, followed by the basal fertilizer (10-26-26) application and then paddy straw cover was done as per treatments. Garlic cloves started germinating after 5 days of planting and after one week of planting about 85% germination of cloves was observed. Soil

salinity (0-15 cm soil) was determined as the electrical conductivity of saturation extract (ECe) in dS/m using a digital electrical conductivity metre. Yield attributes (number of bulbs/m², number of cloves/bulb and 100 clove weight) and bulb yield were recorded from each plot and yield was converted to tonnes/ha.

Weed management

Weed is one of the major biotic stresses of *rabi* season crops in coastal region. There was abundance of weeds under conventional practice of cultivation (Fig 5). Therefore, this method of cultivation required manual weeding to remove weeds (Fig 6), however this operation was done during initial two months before the formation of bulbs.

Weeding as well as intercultural operations was required for loosening the soil and formation of bulbs, however, care was taken not to damage the stem. The improved method of strawponic cultivation of garlic hardly required any weeding and intercultural operations. This saved the labour and reduced the cost of cultivation of garlic in saline soils. The weed biomass was 12.5 g/m² under conventional practice, whereas under paddy straw mulching was only 1.3 g/m².

Soil salinity management

Garlic is generally cultivated in loose, well-drained soils in sunny areas. Sandy loam and silty loam soils are best suited for garlic cultivation. However, for cultivation of garlic in coastal salt-affected areas, alternative management measures are to be followed for managing soil salinity.



Fig. 7. Symptoms of soil salinity stress on garlic crop in conventional cultivation practice and healthy crop without effect of salinity under strawponics.

Under conventional practice the planting of the crop is delayed, therefore, there is loss of soil moisture and build-up of soil salinity (Fig 7). Strawponics crop cultivation helps in earlier establishment of the crop, therefore the crop is not exposed to salinity, which generally becomes a problem in the later part of *rabi* season. Paddy straw cover helps in reducing the soil evaporation; therefore, the capillary rise of salts is restricted and there is less soil salinity development in the crop root zone (Fig. 8).

Irrigation management

Crop cultivation during dry season requires irrigation in coastal region particularly to meet the evapotranspiration requirement of the crops as well as to reduce the soil salinity build up in the crop root zone. However, the irrigation requirement varies depending upon the type of crop. Rice crop requires heavy irrigation as it is grown under standing water condition. Therefore, selection of crops is very important for effective use of scarce irrigation water. Garlic is one of the low water requiring crops, therefore, it is suitable under this situation. Further, alternative cultivation method such as zero tillage planting with paddy straw mulching reduce the irrigation requirement by about 25% compared to conventional cultivation practices. Conventional cultivation practice required initial irrigation whereas in

case of strawponics no irrigation was given after planting as the soil was wet enough for germination. Subsequent irrigations were given at 50% depletion of available soil moisture. Early planting by zero tillage utilizes the residual or carry over soil moisture from the previous season rice crop. Paddy straw mulch, reduces the evaporation loss, suppresses the weed growth thereby conserves the soil moisture and hence reduces the irrigation requirement of the crop.

Harvesting

Garlic crop performance was found to be better under strawponics cultivation method (Fig 9) compared to conventional tillage intensive practices (Fig 10) in coastal saline soil. Bulbs were harvested when yellowing or browning of leaves were seen. Under conventional cultivation, the bulbs were harvested by digging the soil by a spade as bulbs grow underground. The soil adhered to the bulbs were brushed off and cured in an airy, shady and dry place. Under strawponics, harvesting of bulbs were

very easy by just removing the straw cover and gently pulling the plants. It required less labour as there were no earth work and the soils were not adhered to the bulbs. Bulb formation and growth under strawponics occurred inside the paddy straw layers, only the roots enter the soil. After harvesting, the plants were tied into small bundles and drying was done by hanging the bundles on a bamboo stick. Hanging of garlic bulbs hastened the drying as all the sides got good air circulation.

Yield and yield attributes

Number of garlic bulbs per m² was affected, however, the number of cloves per bulb and clove weight increased under strawponics (Table 1). The number of bulbs varied from 35.9 to 45 per m². Lowest number of cloves per bulb (10.9) was observed in conventional cultivation method and it was significantly highest (19.7) with 30 cm row spacing and 7 t/ha paddy straw cover. The 100-clove weight was also the lowest (45.3 g) in conventional system and it increased significantly

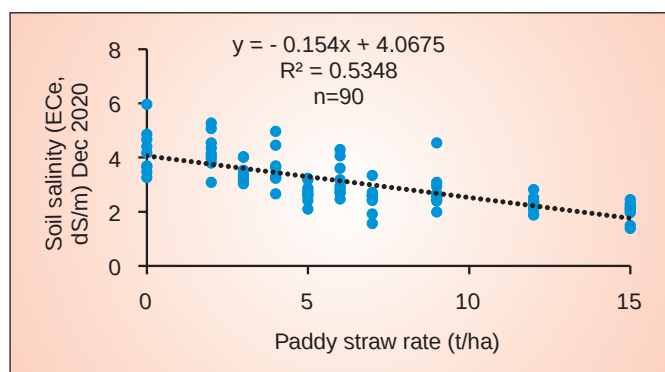


Fig. 8. Relationship between amount of paddy straw used and soil salinity development observed during December 2020 at Canning Town, West Bengal.

Table 1. Performance of garlic under conventional and strawponics

Particulars	Conventional	Strawponics
No. of bulbs/m ²	45.0	35.9
No. of cloves/bulb	10.9	19.7
100 clove wt. (g)	45.3	85.0
Bulb yield (t/ha)	2.26	6.05



Fig. 9. Performance of garlic crop under strawponics



Fig. 10. Poor garlic crop growth under conventional practice

Table 2. Economics (₹/ha) of garlic cultivation in coastal saline soils following conventional and strawponics package of practices.

Items	Conventional cultivation			Strawponics		
	Quantity	Rate (₹)	Amount (₹)	Quantity	Rate (₹)	Amount (₹)
Seed (bulbs)	0.5 t/ha	80,000/t	40,000	0.5 t/ha	80,000/t	40,000
Land preparationi. Machine labourii. Human labour	9 hrs 4 man-days	300/hr 300/man-day	2,700 1,200	Zero tillage planting, therefore no cost for land preparation		
Planting	12 man-days	300/man-day	3,600	12 man-days	300/man-day	3,600
Weeding and interculture	9 man-days	300/man-day	2,700	1 man-day	300/man-day	300
Farm yard manure	5 t/ha	1000/t	5,000	5 t/ha	1000/t	5,000
Fertilizers						
i. 10-26-26	154 kg	27.9/kg	4,296.6	154 kg	27.9/kg	4,296.6
ii. Urea	130 kg	9.6/kg	1,248.0	130 kg	9.6/kg	1,248.0
iii. Sulphur	22.3 kg	48/kg	1,070.4	22.3 kg	48/kg	1,070.4
Insect pests and disease management	-	-	3,700	-	-	3,000
Paddy straw	-	-	-	7 t/ha	700/t	4,900
Irrigation	6 nos.	400/irrigation	2,400	4 nos.	400/irrigation	1,600
Harvesting	10 man-days	300/man-day	3,000	7 man-days	300/man-day	2,100
Post-harvest processing	5 man-days	300/man-day	1,500	5 man-days	300/man-day	1,500
Transportation	-	-	1,000	-	-	1,000
Interest on working capital	73,415	7% p.a. for 6 months	2,570	69,615	7% p.a. for 6 months	2,437
Total cost of cultivation	-	-	75,985	-	-	72,052
Gross return	2.26 t/ha	40,000/t	90,400	6.05 t/ha	40,000/t	2,42,000
Net return (₹/ha)		14,415			1,69,948	
BCR		1.19			3.36	

85 g under strawponics. Highest garlic bulb yield (6.05 t/ha) was recorded under strawponics involving ZT planting with 7 t/ha paddy straw cover and 30 cm row spacing, which was significantly higher over the bulb yield obtained under conventional planting and without mulching (2.26 t/ha). Therefore, for successful garlic cultivation in coastal saline soils, strawponics cultivation practices using ZT planting, PSM and optimum spacing (30×10 cm) should be followed.

Economics

Garlic cultivation in coastal saline soils following conventional package of practices was found non-economical with net return of only ₹ 14,415/ha and benefit cost ratio of 1.19 (Table 2). New package of practices of strawponics involving zero tillage planting and paddy straw

mulching was found to make garlic cultivation in rice fallow land of coastal region economic. Spacing for garlic cultivation is one of the important management practices, closer spacing increases the seed requirement hence increase the cost of cultivation. Under conventional practice the cost of cultivation was found to be ₹ 75,985/ha, which can be reduced to ₹ 72,052/ha by following strawponics cultivation technology. There was a significant increase in net income of garlic cultivation under strawponics cultivation practice. The net income from garlic crop can be significantly increased to ₹ 1,69,948/ha by adoption of strawponics cultivation practices in coastal saline soils. The benefit cost ratio (BCR) can also be increased to the extent of 3.36 following the improved package of practices.

SUMMARY

Garlic is a commercial and high value crop, which can be cultivated in coastal saline soils following strawponics package of practices. Immediately after harvest of *kharif* rice, healthy garlic cloves should be planted under zero tillage condition in the wet soil, followed by covering with 10-26-26 fertilizer, farm yard manure (5 t/ha) and paddy straw (7 t/ha). Proper nutrient and irrigation management with optimum spacing (30 cm row to row and 10 cm plant to plant) should be followed to lower the cost of cultivation and increase net return and benefit cost ratio of this crop in salt affected soils.

^{1,2} & ⁴Principal Scientists, ³Senior Scientist,
*Corresponding author's e-mail:
sksarangicanning@gmail.com

**Share your experiences with
Indian Farming**

Write to:
Editor

INDIAN FARMING

Directorate of Knowledge Management in Agriculture
Indian Council of Agricultural Research
Krishi Anusandhan Bhavan I, Pusa, New Delhi 110 012
indfarm@icar.org.in