Journal of Pharmacognosy and Phytochemistry
Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2018; SP1: 2948-2951

Akhilesh Vishwkarma
Institute of Agricultural Sciences, BHU, Varanasi, Uttar Pradesh, India

AL Jat
Castor-Mustard Research Station, SDAU, Sardarkrushinagar, Gujarat, India

Chhagan Lal
Rajasthan Agricultural Research Institute, SKNAU, Jaipur, Rajasthan, India

J Padmavathi
Agricultural Research Station, ANGRAU, Ghantasala, Krishna District, Andhra Pradesh, India

Correspondence
Akhilesh Vishwkarma
Institute of Agricultural Sciences, BHU, Varanasi, Uttar Pradesh, India

Boost rice production through system of rice intensification

Akhilesh Vishwkarma, AL Jat, Chhagan Lal and J Padmavathi

Abstract
Rice (*Oryza sativa* L.) is the staple food for nearly half of the world's population and most of them living in developing countries. To meet the demand of increasing population of India along with its changing habits and maintain self-sufficiency, the present production level needs to be increased. This has to be done against the backdrop of declining natural resources base such as land, water, labour and other inputs and without adversely affecting the quality of environment. Hence, there is an urgent need to adopt some innovative techniques that could reduce the use of costly input and increase land productivity and water use efficiency so that rice can grow profitably. Among the available technique/ management options to enhance rice production and productivity, hybrid rice and system of rice intensification are the most practically feasible and readily adoptable options.

Keywords: Boost rice, rice intensification

Introduction

1. System of Rice Intensification

System of rice intensification (SRI) is the method, developed in Madagascar in the early 1980's where, it has been shown that yields can be enhanced by suitably modifying certain management practices such as controlled supply of water, planting of younger seedlings and providing wider spacing (Laulanie, 1993). This methodology is gaining momentum all over the world, although it is in a budding stage in eastern Uttar Pradesh of India. SRI is basically a set of modified practices for managing rice plants and the soil, water and nutrients that support their growth. These changes in often age-old cultural practices were assembled and integrated by Fr. Henri de Laulanié, who spent half a lifetime in Madagascar working with small and poor farmers there to improve their rice productivity and output so as to alleviate their families hunger and poverty. SRI addresses the major constraints affecting the livelihoods of small and poor farmers: their limited resources of land, labour, water and cash, as well as losses from pests and diseases and adverse climatic conditions. SRI does not require rice farmers to purchase and use any external inputs, since its benefits derive from changes in the ways that their existing resources are used for rice production. With wider spacing and in a square pattern to give both roots and canopy more room to grow, for taking up nutrients and capturing sunlight; maintaining the soil in mostly aerobic condition, not suffocating the plant roots or beneficial soil organisms; controlling weeds with a simple mechanical hand weeder that also actively aerates the soil; and enhancing the soil organic matter as much as possible with compost or mulch to 'feed the soil' so that the life within it will help feed and protect the growing plants.

2. Nursery management

SRI nurseries should be garden-like, e.i. on raised beds, and unflooded, as this will improve the root growth and vigor of the seedlings. Farmers have many different techniques for raising seedlings, e.i. in a thin layer of soil on trays or pans or on banana leaves, or in plastic trays/cups. This makes it easy to transport seedlings to the field and to handle them gently. Some grow seedlings in a fibrous mat that can be rolled up and carried, a method also used for raising seedlings to be used in a mechanical transplanter. But it is important to lay out the nursery close to the main field so that seedlings could be moved and re-planted in the shortest possible time. It would be ideal to have the nursery in one corner of the main field or adjacent to it. If farmyard manure or vermicompost are applied to the nursery soil, it should be well decomposed; otherwise, the seedlings will be scorched. 2 kg of seed (5 kg/ha) is required to transplant in one acre of land. Seeds should be thinly spread to avoid crowding of seedlings. Care should be taken that no two seeds should touch each other. The nursery to plant 1 hectare of field should be prepared on 100 sq. m. area. For this, it is recommended to prepare 20 beds

of 1 × 5 m each. Beds of 10- 15 cm height can be prepared by scooping out the soil around the beds so that furrows are formed all around the beds. As the roots of 8-12 day-old seedlings grow upto 3 inches (7.5cm) deep, it is necessary to prepare raised beds of 5-6 inches (12.5-15cm) height. In case the native soil is not so fertile, 95 grams of DAP for each 5 m^2 bed may be mixed into the soil before spreading it. Some farmers use a mixture of soil, sand and compost. Vermicompost can also use for its higher quality. If too much sunlight or fog is expected, the nursery could be covered with rice straw for the first two days. This will protect against losses to birds or other creatures as well as shade the seeds or keep them warm.

3. Seed selection and priming: Using a salt-water solution to separate the more viable seeds (which sink to the bottom of a container) from lighter, less developed seeds (which float) can add 10-20% to yield just by having more vigorous seedlings resulting. A process known as seed priming can improve germination rates and enhance seedlings' early growth.

4. Seed preparation and broadcasting

Pre-soaking of seed and broadcasting of sprouted seed is the regular practice recommended for SRI. This process is as follows:

- Soak the seed for 12 hours in water. Then drain the water and transfer wet seed to a gunny bag. Leave it for 24 hours. By this time white root called radicle breaks open the outer coat and starts emerging out of the seed. At this stage the sprouted seed is taken to nursery bed for sowing.
- To ensure uniform broadcasting, divide the whole seed lot into 4 parts and broadcast four times (each part at a time) thinly spread over the bed. It is better to broadcast in the evenings.
- Spread well decomposed FYM or paddy straw (without its grains/seeds) over the sown seed thinly. The seeds are not to be directly exposed to sun. This would ensure protection from birds and ants. Straw can be removed once the seeds germinate. Depending on the requirement, watering should be done daily twice (morning and evening). Watering can be done slowly with pots by controlling the flow with hand. Care should be taken to see that the seeds do not come out while watering.
- The seed bed should be preferably in the center /corner of the plot and it should not be away from the main field, for quick /efficient transplantation. If the area is large, separate nursery bed for each acre is recommended.

5. Preparation of Main Field

This is done similarly to conventionally-grown rice; however, particular care should be given to land levelling, so that water can be very efficiently distributed in small amounts across the entire surface. Field should be evenly levelled and there should not be standing water in the field during transplantation. Where rainfall is heavy, water control can be improved by putting drainage channels around the inside of the field and across the field at intervals of 3-4 meters. In SRI method, seedlings are widely spaced (10 ×10 inch or 25 × 25 cm) and only one seedling is transplanted per hill (3-4 seedlings per hill in conventional system). SRI method can accommodate only 16 hills/square meters as against 33-40 hills/square meters in conventional method. Uniform spacing is also required for easy weeding by implements (conoweeder). To maintain uniform spacing, different methods can be employed. Small pegs can be tied to a rope at 25 cm or 10 inch distance and by using this rope, row after row transplantation can be done. Different types of 'Markers' are being developed for this purpose. These markers need to be run over the prepared field lengthwise and widthwise. Transplanting at the marked intersection gives the required 25 × 25 cm spacing.

Some of the newly developed markers draw 8 rows and columns simultaneously. These markers need to be pulled at an even pace for proper marking. To have the lines straight, it is advisable to tie a rope and pull the marker along side the rope. For smooth transplantation, field operations like bunding, levelling and marking with marker should be completed a day before the transplantation.

6. Method of transplanting

In the conventional method, 21- 30 day-old seedlings are thrust into the puddled soil and the roots take 'U' shape i.e the tips of roots face upward. Therefore the roots require time and energy to turn downward and establish in the soil. In SRI method, young seedlings are planted shallow and therefore establish quickly. Single seedlings with seed and soil are transplanted by using index finger and thumb and gently placing them at the intersection of markings. Light irrigation should be given on the next day of transplantation. Initially, it requires 10-15 persons to transplant one acre. Once the farmers/workers get used to this practice, it can be managed with lesser number of persons.

a) Planting younger seedlings: Usually 10-12 days old, but not older than 15 days. Usually in wet season due to comparatively higher temperatures, 10-day-old seedlings are widely used, but in winter, especially in areas with cold temperatures where very young seedlings sometimes have problems in establishment, farmers prefers to use 12 to 15-day old seedlings. Little older seedlings are preferred in certain areas, particularly in the wet season, where standing water is a problem. In the northern Indo-Gangetic alluvial plains with sandy-clay-loam soil (Ustochrepts), 10-day old seedlings were found most suitable for higher growth, yield and nutrient uptakes under SRI (Shukla *et al.*, 2014).

b) Planting seedling one by one: Though the majority of SRI farmers use one seedling per hill, in some cases they use up to two seedlings. This is mainly to avoid any loss of seedlings due to pest or other damage, which can happen within a few days of transplanting if they are not planted carefully.

c) Planting with wider spacing: There has been no fixed spacing found being commonly used by SRI farmers in generals, but 25 × 25 cm and 30 × 30 cm have been seen most often. Spacing also depends on the inherent quality of the soils. The better the soils, the wider the spacing is appropriate for getting higher yield.

d) Planting seedlings as immediately as possible: Seedlings once uprooted from the seedbed are generally transplanted within half an hour for special care to younger seedling and many farmers have even been seen to avoid any damage of seedling after uprooting, as they arranged seedbeds already inside the main field.

7. Using Manure: Although most farmers use compost/farmyard manure, the amount varies in terms of its availability. Generally 10-15 t ha^{-1} FYM are recommended. Composts are used mostly before transplanting during land preparation, but it is preferred to use this with the preceding

crop. Jat *et al.,* 2015 reported that the incorporation of 50% recommended dose of nitrogen + 50% N through FYM + *Azospirillum* resulted significantly higher grain yield, straw yield it is mainly owing to beneficial effect of organic sources combined with inorganic fertilizer together with *Azospirillum* inoculation and stimulated photosynthesis activities ultimately led to high yield.

8. Alternate wetting and drying irrigation: AWD is practiced up to the initiation of panicles, and then the field is just kept moist. The number of irrigations needed during the entire crop period, and the gap between two irrigations, depends on the type of soil; sandy soils need more irrigation than other types of soil.

9. Wider square spacing: This is important for better growth of roots and canopy. We noted above the recommendation of one plant per hill established in a square pattern, starting out usually with 25 × 25 cm distances between rows and hills. If the soil is not very fertile, for the first year or two, farmers can get somewhat higher yield with two plants per hill and perhaps 20 × 20 cm spacing. But as SRI practices build up soil fertility, through root exudation and additions of organic matter to the soil, sparser planting will give higher productivity (per square meter as well as per plant). It is counterintuitive that reducing plant populations by as much as 80-90% can give higher yield, but this is the result, provided that the other SRI practices are also followed. The higher yield with reduce population results from the increase in panicle-bearing primary tillers per unit area, and also more spikelets and filled grains per panicle, as well as usually higher grain weight.

10. Irrigation and Water Management

Because of some special anatomical features, rice can grow well even in standing water; but it does not require standing water as a rule. The practice of growing rice in inundated condition is mainly to control weed growth. But such conditions result in lack of aeration and consequent stunted root growth. In SRI, irrigation is given to wet the soil, just enough to saturate the soil with moisture. Subsequent irrigation is suggested when the soil develops hairys cracks. Irrigation interval depends on soil type and weather conditions. This method helps in better growth and spread of roots. Regular wetting and drying of soil results in increased microbial activity in the soil and easy availability of nutrients to plants. For a smooth weeding operation, the field should be irrigated maintaining a thin film of water. After the completion of the weeding, water should never be let out of the field. Once the tillering process is complete, standing water of one inch / 2.5 cm height may be maintained.

11. Weed Management

Absense of standing water provides a favourable environment for weeds to proliferate in SRI. If the weeds are incorporated into the soil, they serve as green manure. The general principle of controlling weeds in SRI is to use manually operated cono-weeder/ rotary hoe/power weeder to aerate the soil as well as control weeds. Operating weeder twice 10 and 20 days after transplanting (DAT) reduces the weed problem to a large extent (Dass *et al*., 2015). First weeding should be done 10-15 days after transplating. Later, depending on the need, weeding can be done once every 10 days. The weeds closed to the hills, that could not be reached by the weeder have to be removed by hand. Weeds can be incorporated by moving the weeder between the rows. Mrunalini and Ganesh (2008) opined that the implements like cono-weeder helped to save labour, time and reduced man-days required for weeding from 30 to 10 as the farmers become more experienced in handling the cono-weeder implement.

Advantages of Weeder

- Controls weed
- Green manuring due to incorporation of weeds into soil
- Soil aeration
- Increased soil biological activity
- Increased nutrient availability and uptake

12. Management of Pests and Diseases

The incidence of pests and diseases is naturally low in SRI because of wider spacing and the usage of organic manures. Natural pest management methods and use of natural biopesticides are recommended whenever necessary to keep pests under control.

13. Harvesting and economics

Farmers should be ready to harvest in time as the crop reaches at maturity while it is still green. However, there are certain cases, where both gross and net returns were higher under INM. The use of 100 % RDF alongwith 30 kg N/ha through VC gave the highest net returns (59,804/ha) from SRI (Srivastava *et al.,* 2014).

Advantages of SRI

- Saving of seeds, as the seed requirement is less
- Saving of water, as the water requirement is less
- Withstands short gaps in water availability (like burning of transformers, delayed rains etc.)
- Saving of chemical fertilizers, pesticides
- More healthy and tasty rice due to organic farming practices
- Higher yields due to profuse tillering, increased panicle length and grain weight
- Easy and effective seed multiplication, as a small quantity of seed is required.

Disadvantages

- Higher labour costs in the initial years
- Difficulties in acquiring the necessary skills

References

1. Dass A, Kaur R, Choudhary AK, Pooniya V, Raj R *et al*. System of rice (*Oryza sativa*) intensification for higher productivity and resource use efficiency-A review. Indian Journal of Agronomy. 2015; 60(1):1-19.
2. Jat AL, Srivastava VK, Singh RK. Effect of crop-establishment methods and integrated nitrogen management on productivity of hybrid rice (*Oryza sativa*)-wheat (*Triticum aestivum*) cropping. Indian Journal of Agronomy. 2015; 60(3):341-346.
3. Mrunalini A, Ganesh M. Work load on woman using cono-weeder in SRI method of paddy cultivation. Oryza. 2008; 45(1):58-61.
4. Shukla UN, Srivastava VK, Singh S, Sen A, Kumar V. Growth, yield and economic potential of rice (*Oryza sativa*) as influenced by different age of seedlings, cultivars and weed management under system of rice intensification. Indian Journal of Agricultural Sciences. 2014; 84(5):628-636.

5. Srivastava VK, Singh JK, Bohra JS, Singh SP. Effect of fertilizer levels and organic sources of nitrogen on production potential of hybrid rice (*Oryza sativa*) and soil properties under system of rice intensification. Indian Journal of Agronomy. 2014; 59(4):607-612.