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Review of garlic cultivation under zero tillage in rice straw mulch (*Allium sativum*)

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Abstract
Garlic botanically known as *Allium sativum* is the second most widely used crop of genus Allium after onion (Allium cepa). It belongs to family Alliaceae. It is used as spice and condiments. The edible part of the garlic is its underground stem, which is composed of number of smaller bulbs which is known as cloves. It is a cool season crop. Cool and humid climate is required for vegetative growth and relatively dry period for bulb formation. It can be grown in variety of soil pH ranging 5-7. Garlic has been being cultivated from long time ago but the productivity is very low due to lack of better cultivation practices. So, the cultivation of Garlic under zero tillage in rice straw mulch can be one of the economical and productive method to increase the productivity and quality of garlic. The main objectives of this research was to: review the method of Garlic Cultivation under Zero Tillage in Rice Straw Mulch.

Keywords: Garlic, cultivation, zero tillage, rice straw mulch, productivity

1. Introduction
Garlic (*Allium sativum*) is one of the important spices and condiment. Generally, garlic is cultivated under conventional tillage methods throughout the world. This method includes combination of primary tillage (first deep soil ploughing of soil after harvest of previous crop) and secondary tillage (breaking of clods, leveling land, etc. (Karaye, A.K., Yakubu, A.I., 2006) [4]. The cloves of garlic which is used as propagating or planting materials is either dibbled or broadcasted in the prepared field, maintaining proper distance. This method is time consuming, as it takes a significant amount of time that increases the cost of production. The excessive tillage operation with heavy equipment may destroy the soil structure and may result heavy loss of moisture. The manipulation of soil can also kill the important microorganisms of soil (Aliudding T 1986) [1]. To overcome such problems, researchers and scientists have come with new cultivation technique for garlic cultivation, Zero Tillage Garlic Cultivation.
Zero-tillage is a form of minimum tillage that omits the primary as well as secondary tillage operations. The seeds (cloves in case of garlic) are shown without disturbing the soil either by dibbling or broadcasting. This method has been proven to be beneficial for utilization of residual moisture and nutrient from previous crops (Kwon, K.S., Azad, O.K., Hwang, J.M., 2011) [3]. It also helps in maintaining the soil fertility. But it is recommended for shallow rooted crops only. (Note: Garlic is a shallow rooted crop).

1.1 Objectives
To review the garlic cultivation under zero tillage in rice straw mulch
To review cultivation practices and field requirements
To review the advantage of garlic cultivation under zero tillage in rice straw mulch over traditional method

2. Literature review
2.1 Garlic under Zero Tillage
No till garlic or zero tillage garlic cultivation is practiced in the region of tropical low land. Plain paddy fields are suitable for this technique (also can be done in others lowland area of world). Garlic is sown directly in the soil after rice is harvested. China is the major adopting regions of this method (*en.wikipedia*). It is widely adopted by a large percentage of households.

It is being popular in the south Asian countries as well. It is said to be local initiative started about 20 years ago.

2.2 Cultivation methods of Garlic under Zero-Tillage

2.2.1 Land Preparation

For the cultivation of garlic, land is prepared after harvesting the rice, by leaving 3-5 cm thick layer of rice paddy crop residue on the soil surface (Aliudding T 1986) [1]. (Note: No tillage operation is done in this technique.)

2.2.2 Seed rate and sowing method

Seed rate differs according to planting distance and method of sowing. In normal case, 500 kg of cloves of diameter 8-10 mm is enough for 1 hector of land (Karaye, A.K., Yakubu, A.I., 2006) [4]. In order to maintain proper spacing, rice should be planted at spacing of 15cm×15cm or 20cm×20cm (since the cloves are shown in the remain residual part of the rice). The spacing also depends on rice to be cultivated and garlic to be sown after harvesting of rice. The cloves are dibbled directly in the remain of the rice after harvest, making a hole in between with rod or sickle. Each residual part is dibbled with a single clove.

2.2.3 Fertilizer management

The surface application of the fertilizer causes great loss of fertilizers by volatilization as fertilizers are not incorporated in the soil. This may increase the fertilizers amount to be used. In order to prevent that, mulching of the field after fertilizer application is most. Organic fertilizers should be incorporated during the land preparation prior to planting rice, that also benefits the garlic. The recommended dose of fertilizers is 120:80:80 kg NPK per hector of land. Phosphorous and Potassium should be applied as basal dose. Nitrogen can be also applied as basal as well as split dose.

2.2.4 Mulching Technique

This method requires mulching. It is most important part of the cultivation. A significant difference is seen between mulched and open cultivation of garlic under zero tillage condition. It reduces the nutrient loss and also preserve the residual moisture required for garlic.

2.2.4.1 What sort of mulch is required?

As mentioned above, mulching is most under zero tillage. It increases the productivity of the crop. It decreases the soil temperature (Garlic is cold season crop). The efficient conservation of water and uses of water can be achieved. High temperature may suppress the rate of root elongation decreasing the root density that decreases the water uptake.

Different material can be used as mulch. However, rice straw mulching is seen to be the best one. Water hyacinth, Sotty leaf of ginger can also be used. Researches done to find out the best mulching materials have shown that better emergence of plant is seen in rice straw mulch (M B Mahdie, Najafabadi Gh, MH Asil and Jamal-Ali Olfati 2012) [11]. Other parameters like leaf area, leaves per plants, bulb weight, diameter, cloves per bulb, etc. was also high in case of rice straw mulched, followed by water hyacinth and sooty leaf mulch. No mulching at all has major reduction in production and productivity of garlic. So, rice straw mulch is most important and is necessary of high yield.

2.2.5 Irrigation

Irrigation is important factor for crop cultivation. The productivity is directly related with the amount of water available when needed by the plant. The residual moisture preserved by mulching plays initial role in germination of cloves. So, irrigation may not be required. However, in later phase of growth, water may be required based on the soil moisture content. Irrigation should be provided once a week after monitoring the soil moisture level. Irrigation should be stopped a week before harvesting. Excess water (flooding) may cause rooting of the root. So, it should be avoided.

3. Conclusion

The technique has become popular these days throughout the world. Many researches have been carried out to find out its practical significances on production. Researches have shown a remarkable result in this method. Comparing the pattern of growth and development, studies have shown that the emergence rate is highest in case of zero tillage. Compared with the conventional tillage method, the emergence percentage is 3% in zero tillage (Halim A 2000) [2]. Similarly leaf area, fresh weight and roots per plant is higher in this technique. The other measuring index like leaf area, fresh weight of bulb was also high. Similarly, the clove per unit bulb and diameter of the bulb were also high in zero tillage.

4. Recommendations

One of the major reasons for innovations of new ideas is to improve the performance of the crop, using locally available resources and increasing its productivity. In normal condition of conventional tillage, the productivity is 6 tones per hector. But with the practices of zero tillage in the same condition, the productivity can be increased up to 10 tones per hector. The increment in productivity is directly linked with the method of cultivation. But it is to be noted that zero tillage is only beneficial if it is provided by mulch. In absence of mulch, the soil moisture loss is high as mentioned above, increases the soil temperature and loss of nutrient is seen. This causes the reduction of the production of the crop. Zero tillage of garlic is seen to have the least emergence, least height, diameter, cloves per bulb, in comparison to the mulch (either rice straw or water hyacinth or sotty leaves). This ultimately reduces the production. So, The Garlic Cultivation under Zero Tillage in Rice Straw Mulch is highly recommended.

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