EFFECT OF TILLAGE PRACTICES AND SEED PRIMING ON GROWTH AND YIELD OF UPLAND CROPS IN RICE FALLOWS – A REVIEW

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ABSTRACT

The practice of puddling benefits rice cultivation but it adversely affects the succeeding upland crops by altering the physical, physico-chemical and microbial properties of the soil. The key to successful management of upland crops in rice fallows lies in maintenance of optimum plant stand by manipulating the soil tilth by proper tillage practices, seeding and stand establishment techniques like seed priming. Priming is a pre-sowing practice by which seeds are allowed to imbibe moisture or liquids followed by drying. Many experiments proved that primed seeds ensure proper germination and good stand of many crops especially upland crops grown in rice fallows, than non-primed seeds. The information on tillage and seed priming effects on upland crops in rice based cropping systems has been reviewed hereunder:

Effect of tillage on germination, seedling establishment, growth and yield of upland crops

Seedling emergence is critical for better establishment of crop. Hence, it is important to ensure an adequate seed and soil contact to facilitate water movement into seed, which intern depends upon physical characters of seed bed, thus affect germination and plant stand (Bouaziz, 1987). Thus, tillage practices assume importance for the establishment of upland crops in rice fallows.

Emerson et al. (1978) and Khan and Datta (1983) evaluated the effects of different tillage practices and concluded that rotary tillage was effective in producing smaller aggregates of 4-6 mm diameter which provided a better seed soil contact and increased the availability of moisture resulting in better emergence of wheat seedlings. On the contrary, seedling emergence was found to be the lowest when soil was tilled with mould board plough and disc plough, due to formation of bigger size clods. However, Pratibha et al. (1995) reported that germination percentage of sunflower in rice fallows was higher when land was prepared by ploughing with tractor drawn mould board plough once followed by disc harrowing than under zero tillage. In an another experiment Singa Rao et al. (1995) observed low germination percentage of groundnut at 15 DAS in raised seed bed because of formation of bigger size clods due to poor seed soil contact while it was higher in soil pulverized using disc harrow.

In an experiment on castor grown in rice fallows, Pratibha et al. (1994) reported that ploughing once with tractor drawn mould board plough plus rotavator twice resulted in lower bulk density and higher moisture availability which inturn favoured better seedling emergence and ultimately improved the yield.

Gurumurthy and Singa Rao (2003) reported that in sandy clay loam soil seedling emergence of sunflower in rice fallows was higher in secondary tillage with rotavator drawn either by tractor or power tiller. The germination percentage of rabi sunflower grown in rice fallows was higher (78.1 %) with tractor drawn disc plough once followed by rotavator once and the lowest percent of germination was observed in zero tillage (48.6 %) treatment (Dharmajith Kanungo, 2001).

Growth parameters

Root growth

Tillage is an important activity to loosen the soil for better root growth and crop
establishment. Gupta et al. (1984) reported that root extension of sorghum in early part of growth in tilled clayey soil was faster especially in previously puddled transplanted rice soil and reached up to 30 cm depth in 20 days after sowing compared to 10 cm depth in no tillage treatments.

Tillage with tractor drawn implements and rotavator resulted in creation of optimum soil physical conditions which inturn significantly favoured the root growth and nodulation of groundnut (Vijaya Kumar, 1991)

Vijaya Kumar (1991) and Singh and Singh (1996) though evaluated the tillage systems, they observed on the other hand that ploughing with tractor drawn disc plough resulted in higher root length (22-23 cm) and root dry weight of sunflower crop over shallow tillage (ploughing with country plough) in sandy clay loam soils at Hyderabad. (Gurumurthy, 2000)

**Above ground portions**

Gill et al. (1996) opined that plant height and dry matter production of maize was significantly greater with deep tillage than conventionally tilled plots (shallow tillage) in loamy sand soils of Punjab. Omer and Elamin (1997) reported that sorghum plant height in chisel ploughed plots was taller by 24, 32 and 45 cm than broad bed and furrow, ridge and furrow and no till plots, respectively. In red sandy loam soil, when groundnut crop was grown in rice fallows, irrespective of the crop growth stage, the dry matter production with disc plough + rotavator was superior over tillage with country plough alone. According to Vijaya Kumar et al. (1999) variation among tillage treatments could be attributed to differences in seedling emergence and stand establishment.

**Yield attributes and yield**

Khan (1984) from Kharagpur reported that maximum peanut pod yield (3.22 t ha⁻¹) was obtained with deep tillage using mould board plough and disc harrow which might be due to better soil physical environment for plant growth in sandy loam soil. The increase in yield was 67 and 78 per cent compared to that of rotary and no tillage, respectively. Lindsay et al. (1983) reported that deep tillage to a depth of 30 cm by discing followed by two rotavations in a fine textured soil had 40 per cent higher yield of corn ears on fresh weight basis compared to zero tillage and shallow tillage to a depth of 15 cm by rotavator. Shetty and Moody (1984) observed increase in mung bean yield with optimum tillage compared to that of zero tillage in puddled transplanted rice fields but not much in direct seeded rice field. In contrast to the finding, conventional tillage significantly increased maize and mung bean yield by 24.2 and 78 percent, respectively in clay loam soil over no tillage treatment (Sharma et al., 1988).

Aggarwal et al. (1997) conducted field experiment at IARI, New Delhi during 1991-92 and 1992-93 in clay loam soil and reported that the average grain yield of rabi wheat grown after puddled rice was significantly higher with chisel plough (34.0 and 44 q ha⁻¹) and disc plough (31.9 and 43.6 q ha⁻¹) than minimum tillage (28.9 and 36.0 q ha⁻¹).

**Effect of tillage on nutrient uptake**

Vijaya Kumar (1991) observed significantly higher uptake of nitrogen, phosphorus and potassium by groundnut crop in deep tillage by bullock drawn implements (disc ploughing followed by disc harrowing). It was mainly due to creation of pulverized tilth which offered minimum resistance to root growth and subsequently encouraged nutrient uptake even from deeper layers. In sandy loam soils of Rajasthan, disc ploughing was superior to the rest of the tillage treatments for nutrient uptake by sunflower, followed by chisel ploughing. conventional tillage, minimum tillage and zero tillage (Laddha and Totawat, 1997).
Effect of seed priming on germination, seedling establishment, growth and yield of upland crops

Crop establishment

Seed priming is a technique of controlled hydration and drying thus result in more rapid germination when the seeds are reimbibed. Priming has resulted in increased rate and uniformity of germination and enhanced rate of synchrony and percentage of seedling emergence in many crops under field conditions. The benefits of seed priming have been reported in rice and other plant species by Lee et al. (1998); Qin and Zheng (1994), Brad ford (1986) and Pill (1994).

However, most of the work has been done on wheat (Misra and Dwivedi, 1980 and Sen and Misra, 1984). Seed priming with growth regulators such as GA, ABA, kinetin and ethylene and heat treatment of seeds are known to be the effective techniques for rapid, uniform seed germination of various crops (Hurly et al., 1991).

Priming of seeds in a poly ethylene glycol solution improved the overall germination rate and uniformity of growth and reduced the time for germination, particularly in many vegetable crops such as celery (Drew and Dearman, 1993), parsley (Akers, 1987), tomato (Muhyaddin and Wiebe, 1989), onion (Furutani et al., 1986) and leek (Nienow et al., 1991). Similar seed priming effects were also observed in some of the field crops such as corn, barley, wheat, sorghum and soybean (Bodsworth and Bewley, 1981) under the adverse environmental conditions such as sub optimal temperatures or inadequate soil moisture conditions.

Shoot and root length

Priming with Indole Acetic Acid (IAA) had improved the root length, speed of germination and vigour index of seedlings. The role of IAA on growth of sorghum seedlings was well documented by Dennis and Page (1978) and Patel et al. (1978) in maize and pigeonpea (Nayyar and Malik, 1993).

Growth attributes

Chippa and Lal (1988) noted that seed soaking in IAA increased the plant height. On the other hand, Reena et al. (1999) found that priming in IAA (100 ppm) and kinetin (25 ppm) solution was most effective in significantly increasing the plant height, number of branches and leaf area per plant over control in soybean. It might be due to the increased metabolic activity of the plant causing increased uptake of N, P, K and Ca in wheat grown on sodic soil.

In another experiment, Kaur et al. (2002a) observed positive effect of hydopriming (with 4 % mannitol and water for 24 hr) on seedling growth and enzymes of carbohydrate metabolism during germination and shoot dry weight under water stress conditions.

Yield attributes and yield

Misra and Dwivedi (1980) reported positive effect of seed priming with potassium and distilled water on growth, dry matter accumulation, grain and straw yield in 12 wheat varieties under rainfed conditions. Paul and Choudhary (1991) also observed such results from Assam in wheat, in rice by Thakuria and Sarma (1995) and in chickpea in Bangladesh by Musa et al. (1999). Musa et al. (1999) also stated that seed priming helped chickpea plants to escape from terminal drought.

Harris and Jones (1997) have demonstrated variation in response to priming amongst rice varieties and have postulated that priming of upland rice seed could be beneficial in West Africa and other environments where weed growth is an important constraint to achieve higher yields.

Kumar et al. (2002) reported that 8 hours priming of finger millet seeds in water resulted in an increased mean plant height by 9 cm, reduced mean time to 50 per cent flowering and maturity by about 6 days and significantly increased grain yield. According to Kaur et al. (2003), in non-primed chickpea crop, the average seed yield per plant was 3.61 g and with water
and mannitol priming the average seed yields per plant were 5.05 and 5.94 g, respectively showing an increase of 39 and 64 per cent respectively

Primed seeds of rice-chickpea cropping system helped in accumulation of greater amount of soil N than fallow. System the grain yield, dry matter and N accumulation significantly higher in rice-chickpea system than that of rice fallow (Patil et al., 2001).

On farm trials comparing primed and non-primed seeds in Indian states of Rajasthan, Gujarat and Madhya Pradesh have shown positive results on faster emergence, better crop stand, more vigorous plants, early flowering, early maturity and higher seed grain yield of maize, upland rice, wheat and chickpea sown into seed beds reliant on either rainfall or residual soil moisture (Harris et al., 1999 and Murungu et al., 2004).

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