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REVIEW ARTICLE

INFLUENCE OF ESTABLISHMENT METHOD ON RICE AND WEEDS

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ABSTRACT

The traditional way of transplanting of rice is very massive, labour intensive, time consuming and costly. It requires raising of nursery, it's uprooting, transplanting in the field and continuous ponding of water for the first 15 days. Non- availability of timely labour cause late planting and ultimately reduces the yield. Change in rice establishment method from traditional manual transplanting of seedlings to direct seedling. Weed infestation to be major bottleneck in dry seeded rice because of simultaneous emergence of rice and weeds and at the time of early growth absence of water, which can suppress weed growth.

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INTRODUCTION

Scarcity of freshwater in the world's leading rice producing countries such as China and India is limiting the production of the flooded rice crop. Since more rice to be produced with less and less water to feed the ever-growing populations, it needs judicious water management practices and suitable water saving techniques in rice cultivations [71,5]. Several such technologies like saturated soil culture alternate wetting and drying system of rice intensification, direct seeding and aerobic rice have been developed in recent years. These approaches are receiving increasing attention because they increase the water use efficiency mainly by reducing unproductive seepage and percolation losses and evaporation [5,10]. In India, 44 per cent area under transplanting of rice in irrigated conditions. Transplanting of rice is very cumbersome, labour intensive, time consuming and costly. It requires raising of nursery, its uprooting, transplanting in the field and continuous ponding of water for the first 15 days. This is turn needs to nutrients losses through leading besides causing evapo-transpiration (ET) losses during the hot summer months. Rice production under current inputs and technology likely to fail to meet the projected demand [35] besides an urgent need to increase rice productivity per unit area in the world, Increasing yields in aerobic rice system "the direct seeded rice" can play a key role in increasing rice production globally [42]. Therefore DSR offers the advantage of faster and easier planting ensure proper plant population, reduce labour and hence less drudgery, 10-12 days earlier crop maturity, more efficient water use and higher tolerance to water deficit and often high profit in areas with assured water supply [16, 17]. Change in rice establishment method from traditional manual transplanting of seedlings to direct seedling has occurred in many Asian countries in the last two decades in response to rising production costs especially for labour and water [12]. Weed infestation however countries to be major bottleneck in dry seeded rice because of simultaneous emergence of rice and weeds and absence of stand water at the early stage of crop to suppress weed growth [46,13,19]. With two availability of proper weed management technology, it is possible to raise the productivity of dry seeded rice. Yield of dry seeded rice were broadly comparable with those of transplanted rice in absence of weed competition [61]. Soil disturbance has a strong influence on the size, profile distribution and species density of weed seed bark [26]. Rice provide the 21% of the total calorie intake of the world population. Transplanting is the most dominant and traditional method of establishment in irrigated low land rice. The area under transplanting rice in world is decreasing due to scarcity of water and labour. Direct seedling reduce labour requirement, shorten the crop duration by 7-10 days and can produce as much grain yield as that of transplanted crop. It needs only 34% of the total labour requirement and saves 29% of the total cost of the transplanted crop [29].

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Effect on rice growth parameters

Plant Height: More plant height was recorded was direct sown rice than transplanted rice, might be due to the transplanting shock which may take about one week for establishment in transplanted rice (Prabhakar, 1996). In contrast Singh *et al.*, 1997 observed higher plant with transplanted rice.

Dry Matter Production: The higher dry matter accumulation was under direct seeded rice in puddle condition and SRI compared to regular transplanting [20]. Direct seeded rice with and without brown manuring produced significantly more LAI than both methods of transplanting with machine in zero tilled plots to conventional methods [73].

Machine transplanting of basmati rice after pudding produced more LAI over to all other methods of establishment [20,18,22].

Tillers/m²: Transplanting of rice seedling registered higher number of tillers on sandy 100m soil during wet season [42]. Transplanting of rice on the same day of direct sowing produced significantly more tiller/m² (320) than the crop transplanted after 25 days of sowing (276.9m²) [24]. In contrast [7] produced maximum tillers m²(236) in direct seeded rice than manual transplanted crop (229/m²). [22] Higher tillers/m² with machine transplanting after pudding was at par with direct seeded basmati rice with brown manuring.

Root parameters: Increase in root weight due to uses of paady transplanter [61]. The roots of rice plants have least competition under wider spacing so that growth is stimulated by sunlight and space for the canopy expansion [43]. SRI plants had considerably greater root length density in the lower soil horizons (0-20 cm) compared with roots of plants of the same variety conventionally grown in the same soil and it was 2.3 times more at 30 to 40 cm depth, and 3.8 times more at 40 to 50 cm [8]. Higher root dry weight and root volume in SRI than conventional method, irrespective of varieties during wet season at Maruteru on clay loamy soils of Godavari delta [44].

Effect on physiological characters and microbial population: The higher content of proline, non-protein nitrogen and soluble sugars in leaves were more in SRI methods, with high rate of conversation and translocation rates from vegetative parts [50]. Microbes harbouring rhizosphere of crops provide benefits to crops through better nutrient availability by way of atmospheric N_2 fixation or solubilizing fixed mineral forms of nutrients [41]. The population of soil heterotrophic bacteria and phosphor-bacteria was tremendously increased by planting 14 day old seedlings, limited irrigation, weed incorporation and green manuring. Incorporation of weeds is increase population of *Azospirillum* and *Azotobactor* at 50 % flowering and panicle initiation stage, respectively [21]. Under SRI method higher microbial biomass C and N was obtained than conventional method [74]. The microbial activity increased by soil aeration due to mechanical weeding under SRI, which increased enzyme activities (amylase, catalase and dehydrogenase). Initially herbicides suppressed soil microbial population and later due to more rice crop -root association get increased might have utilized more root exudates secreted by the crop [33].

Yield attributes and yield: Observed significantly higher number of particles per unit area in net seeded rice (429 m²) than in transplanted rice (248 m²)[66]. Maximum panicle length was observed in direct sown rice crop over transplanted crop [53]. However, according to [23] there was no significantly difference in Panicle length and test weight on account of method of crop establishment. Among four rice establishment methods transplanted rice resulted significantly higher gain yield (3.98 t/ha) followed by drum seeding (3.37 t/ha) broadcast seeding (3.27 t/ha) of sprouted seeds and row seedling (2.95 t/ha) in prepared bad [36]. In sandy loam soil of PAU, plant height was significantly higher with machine transplanting of basmati rice after pudding than other method of planting [22]. The basmati rice height under direct seeded basmati rice without brown manuring was at par to direct seeded basmati rice with brown manuring [60, 72].

Test weight is a function of various production factors that gives an indication of grains development and filling patterns as influenced by various factors. Crop establishment method did not affect test might of rice crop [22,23] machine transplanted basmati rice after paddling resulted in 3.12, 3.12, 3.12, 3.12 and 6.45% higher grain yield over direct seeded basmati rice without brown manuring, convention transplanting, machine transplanted rice in zero tilled plots with brown manuring & machine transplanted rice in Zero tilled plots without brown manuring in sandy loam condition [22].

Effect on weeds: At tillerring flowering and maturity stages on sandy loam soils, [11], registered significantly lower weed dry at in transplanted rice than in direct seeded rice. Also agree with this [64]. The lowest populations of the weed in transplanted rice compare to direct sowing [72]. Weed density and weed dry matter production was significantly higher in wet seeded rice compared to transplanting [65].The choice of rice establishment methods is one of the important for rice cultivation, because of weed is major problem. The grassy weeds in rice reduced in standing water and also some extent sedges reduced. The methods should be choice on the previous history of field [6,7]. Suggested higher seed rate under aerobic soil conditions for avoiding poor seedling establishment as well as for weed management [4]. The method of sowing and east –west direction of row seeding reduced weed and also lower yield loss.

Dominant weeds: The direct seeded rice field was dominated by Jangle rice (*Echinochloa colona)* bahia grass (*Paspalum notatum flugge*) goat weed (*Ageratum conyzoides* L.) and wood sorrel (*oxalis latifolia* H.B.K.). day flower (*Commelina benghalensis* L.) gallant soldier (*Galinsoga parviflora* Cav.) spurges (*Euphorbia geniculata* Forsk) signal grass (*Brachiaria ramose* stapf) crop grass (*Digitaria sanguinalis* (L)) purple nut sedge (*cyperus rotundus* L). and Bermuda grass (*Cynodon dactylon* (L) Pers) were also observed in low densities in sandy clay loam area of Almora [25]. In sub-tropical area with annual rainfall of 1386 mm & clay loam textured soil, study the weed infestation of 60 days after sowing. The dominant weeds with rice were own less barnyard grass (*Echinochloa colona*) rice flat sedge (*Cyperus iria*). Caesulia (*Caesulia axillaris* Roxb) & sessile joy weed [*Alternanthera sessilis* (L) D.C]. Due to prolonged initial water submergence wrinkle duck weed (*Ischaemum rugosum salis* b.) and blistering ammania (*Ammania baccifera*) were observed as new weeds in low density. The emergence of *Echinochloa colona* was greately influenced by the tillage system. Zero tillage rice had maximum emergence of *Echinochloa colona* than conventional tillage [12,37,65]

At Kashipur major weed species were *Cyperus rotundus* (21.4%), *Eleusine indica* (19.8%) *Dactyloctenium aegyptium*

(16.9%), *Echinochloa colona* (10.2%) *Corchorus actutangulus* (9.9%). *Alternanthera sessilis* (9.9%) & *Leptochloa chinensis* (8.0%) observed and density of *Echinochloa colona*, *Digitaria aegyptium*, L. Chinensis & *Echinocloa indica* was higher in wet seeded rice (WSR) followed by direct seeded rice & zero tilled rice (ZTR) [60]. In direct seeded rice plot of Kanpur infestation of *Echinocloa colona* (23.7%), *Echinocloa* glabrescens (13.1%), *Echinocloa* alba (11.01%), *Cyperus iria* (37.5%) & P. niruri (14.1%) was recorded [56].

Effect on nutrients: In silty clay loam soil of pantnagar having high O.C (0.90 %), medium unavailable P (19Kg P ha^{-1}) & high in available Potassium (225 Kg K ha^{-1}) with pH 7.65 under DSR major weed species sound were *Caesulia axillaris* (59.8%) *Echinochloa colona* (14.7%) Panicum maximum (11.7%) *Cyperus iria* (5.7%) & *Ischaemum ruyosum* (20%) [66]. Soil of Jabalpur was clay loam (Typic chromusterts), medium O.C (0.66%) low in available nitrogen (239 Kg/ha), medium in available P (17Kg/ha) & potassium (298Kg/ha) density of *Phyllanthus* spp, *Physalis minima* & *Lorchorus* spp was less in soybean as compared to DSR [37] Weeds removed eight times higher nutrients under direct seeded rice compared to transplanting [55]. The nutrient uptake by weeds was 30Kg N, 10Kg P + 17Kg K per hectare in transplanted rice in clay loam soil of Coimbatore [68]. Nutrients removal by weeds was significantly higher in broadcast/ direct sowing compared to transplanted methods [49].

Rice yield loss due to weeds: Yield losses are largely dependent on the season, weed species, weed density, rice cultivar, growth rate, management practices and rice ecosystem. Weedy rice cannot be harvested and it reduces yield because it matures earlier than cultivar rice, shatters and lodges easily [7]. On average, rice yield loss due to weed ranges from 15-20 % but in severe case the yield loss may exceed 50 % [27] or even 100 % [37, 32]. Season long weed competition in direct seeded aerobic rice may cause yield reduction upto 80 % [69]. In extreme cases, weed infestation may cause complete failure of aerobic rice [32]. Thus direct seeded aerobic rice is highly vulnerable to weeds compared with other rice ecosystem [4]. In tropic average rice yield losses from weeds is 35% [15] while in direct seeded rice yield penalty is as high as 50-91% [46]. As stated season long weed competition in direct seeded rice may cause yield reduction up to 80% [69].

Influence on labour productivity, economics and energy: The 30 man h ha^{-1} in rice transplanter compared to 126 man h ha^{-1} in hand transplanting labour input [1]. In 2002 [30] recorded that higher energy output: input ratio (15.78) in SRI compared to transplanting (13.28) and aerobic rice (12.42). In 2010 reveled that the SRI methods have higher energy output: input ratio (18.84) than manual transplanting [31].In machine planting, gross return was low (37141.90 ha^{-1}) with a higher net returns and B:C ratio of 2.82 compared to line transplanting because of the low cost for nursery preparation and in transplanting [48]. while conducting field experiments on sandy loam soil at a research farm in Meerut, U.P. observed that time saving in zero till wheat and strip till wheat was 75.2 and 74.2%, labour saving was 64.3 and 64.3%, fuel economy was 79.1 and 77.9% and energy saving was 79.2 and 78.2% as compared to conventional sowing of wheat[55]. From Haryana, observed that the fuel consumption in rotary and zero tillage was 14.2 and 6.0 l ha^{-1}, respectively, as compared to 65 l ha^{-1} in conventional and 80 l ha^{-1} in FIRBS of wheat cultivation [14]. The amount of fuel required was 60-70 % less in strip and zero till drill. They further indicated that energy output: input ratio was 6:6.98 in strip till drill against energy output: input ratio of 5:5.52 in conventional sowing [57]. From Pantnagar observed maximum fuel consumption of 7.50 l ha^{-1} in case of rotary powered disc residue drill and minimum of 4.25 l ha^{-1} with star wheel punch planter [45]. From Etawah, reported that fuel consumption in zero tillage system was much less (5.88 l ha^{-1}) than that of conventional tillage (27.75 l ha^{-1}) [47]. Evaluated energy inputs under different tillage mode and reported that in minimum tillage (strip till drill) and direct drilling system, there was significant saving in energy [28]. The operational time and fuel consumption in tillage and sowing were minimum in zero tillage than conventional. They further reported that time economy was 10.14 and 8.33 h ha^{-1} and fuel economy was 40 and 33.88 l ha^{-1} with New Zealand zero-till ferti-drill and Pant zero-till ferti-drill, respectively as compared to conventional tillage [59]. While working on zero strip till drill under varying soil conditions reported that under minimum tillage system, the fuel consumption in planting operation was 18 l ha^{-1} against 60 l ha^{-1} under conventional tillage [54]. The energy cost of manual and mechanical inputs was 46 and 54 per cent, respectively of the total energy in rice-wheat production system [2]. The seed bed preparation and sowing collectively used half of the total operational energy incurred wheat production [67]. An economy of 40 per cent energy in seed bed preparation was observed under minimum tillage without affecting wheat yield [2].

From Patna, Bihar reported that adoption of zero tillage saved Rs. 1783 ha^{-1} towards land preparation, Rs. 1233 ha^{-1} towards sowing and Rs. 451 ha^{-1} towards irrigation [64]. Maximum net return (Rs. 18560 ha^{-1}) from reduced puddle rice, followed by that of unpuddled direct seeded rice, puddling by rotavator and conventional puddling treatments [63]. The highest net returns (Rs. 6571 ha^{-1}) was obtained from zero tillage, followed by minimum tillage (Rs. 5863 ha^{-1}) and deep tillage (Rs. 5253 ha^{-1}) [38]. The zero tillage involved less cost and incurred more benefit: cost ratio than rotavator twice, rotavator once and farmer's practice [40]. The rotary tillage was the best option as gave highest net returns (Rs. 25496 ha^{-1}) followed by zero tillage [13]. Under wet sprouted seeding, cost of cultivation was 18 % less than that of transplanting [59]. The net income and benefit: cost ratio were higher in wet seeding than manual broad casting, followed by wet seeding by drum seeder. The strip till drill wheat gave higher net return (Rs. 29090 ha^{-1}), benefit: cost ratio (3.67) but lower specific cost (1.19 kg^{-1}) than other methods [70, 52, 66]. Observed the tillage operations formed a major cost of production in wheat crop [34]. The cost of cultivation of wheat crop under conventional tillage was 1.5 times more than that of no tillage system[51]. Rice production required much higher energy input, chiefly due to high water requirement and transplanting than the upland rice [39].

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