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Nursery fertilization of rice (*Oryza sativa*) with native weed vegetation

R.A. RAJU, M.N. REDDY AND B. GANGWAR[1]

Agricultural Research Station, Acharya N.G. Ranga Agricultural University, Maruteru, Andhra Pradesh 534 122

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ABSTRACT

A field experiment was conducted on a clay-loam soil during the rainy (*kharif*) season of 1995 and 1996 at Maruteru, Andhra Pradesh, to evaluate the performance of some succulent weeds as green-leaf manure in rice *(Oryza sativa* L.) nurseries. Fertilization of nursery, irrespective of source, greatly improved the seedling height, production of leaves, biomass, root number, root length and seedling growth rate. Among the green-leaf manure weeds, maximum values of seedling parameters were noticed in *Crotolaria verrucosa* L.-treated plots which was on a par with *Casia angustifolia* Vahl and *Calotropis gigantea* (L.) R. Br. ex. Ait. green-leaf incorporation. The seedlings were shorter and had sparse and thin root system in *Croton sparciflorus* L.-treated plots. The legume weed (*Crotolaria verrucosa*)-treated plots yielded 2.15 times more seedling bundles (226) than unfertilized plots. Pulling the seedlings was easy and took short time when the nursery received either organic or chemical fertilization. Unfertilized seedlings and those received basal fertilization established very quickly in the main field than those where N was top-dressed before pulling in the nursery. Green leaf manuring irrespective of its source suppressed the weed-seed germination of *Echinochloa glabresence*. Highest grain yield (52.4 q/ha) was obtained in plots received *Crotolaria verrucosa* green-leaf manuring and it was at par with other green leaf weeds except *Croton sparciflorus*.

Key words : Rice nurseries, Green-leaf manuring, Wasteland, *Echinochloa glabrescence*, Seedling output, Pulling time, Weeds

A vast array of quick-growing weed species that grown on wastelands are being used in rice nurseries by previous generation of farmers. Since last decade, these were replaced by inorganic fertilizers as a readily available nutrients. Due to rising costs and limited availability of fertilizers in developing countries, poor farmers deter from using them in recommended quantity (Ladha and Garrity,

Present address : [1]PDCSR, Modipuram, Meerut, Uttar Pradesh 250 110

1994). Worldwide energy needs and growing concern over environmental degradation call for partial substitution of industrial fertilizers with renewable natural weed vegetation. Adequate nutrition to nursery is an important factor to get healthy rice seedlings (Raju *et al.*, 1986). Sufficient information is not available on the utilization of some of the nutrient-rice weeds grown in wastelands abundantly for the rice nurseries. Hence the present study was undertaken.

MATERIALS AND METHODS

A study was conducted during 1995 and 1996 on a Godavari clay loam soil belonging to the sub-group Vertic Chromusterts at the Agricultural Research Station, Maruteru (16.38° and 81.4° E, 5 m above mean sea-level), the Coastal agro-climatic zone of Andhra Pradesh. The climate of this region is tropical subhumid.

The experimental land had been under lowland irrigated rice for a number of years. The soil was near neutral (pH 6.9), medium in organic carbon (0.62%), available N (61 ppm), available phosphorus (14 pm, Olsen's method) and high in exchangeable potassium (123 ppm). The treatments consisting of chemical fertilizers and 5 native weeds (Table 1), were arranged in randomized complete block design. The experiment in nursery as well as in the main field was replicated 4 times. The trial was conducted during the wet season (June–October). Cultivar 'Vijeta' was soaked in water for 24 hr and incubated for 36 hr before broadcasting at 5 kg seed/ bed (40 m^2). Nursery beds were received fertilizer as per the treatments (Table 2). The weeds were collected from wastelands and analysed (Table 1) before incorporation into the soil.

The main field received uniform dose of 120, 60 and 40 kg/N, P_2O_5 and K_2O/ha. Thirty days old seedlings were planted at 20 cm × 15 cm spacing. The field remained always flooded (4 cm depth) up to crop ripening.

RESULTS AND DISCUSSION

Seedling characteristics

Seedling height, production of leaves, biomass and root number in rice were significantly influenced by fertilization to nursery. Application of chemical fertilizers as basal showed the maximum values of seedling parameters and it was on a par with green, leaf manuring with weeds except *Croton sparciflorus*. Highest growth

Table 1. Composition of weeds used for green-leaf manuring

Common name	Botanical name	Family	N (%) in leaf (on dry-weight basis)
Rattle worts	*Crotolaria verrucosa* L.	Fabaceae	3.1
Indian madder	*Calotropis gigantea* L. R. Br. ex. Ait.	Asclepiadaceae	1.9
Tinnevelly senna	*Casia angustifolia* Vahl	Caesalpiniaceae	2.1
Physic nut	*Jatropha curcas* L.	Euphorbiaceae	1.6
Jungle chillie	*Croton sparciflorus* L.	Euphorpiaceae	0.92

Table 2. Seedling characteristics as affected by inorganic fertilization and green-leaf manuring in rice nursery (mean data of 2 years)

Treatment	Germination (%) 10 DAS	Height (cm)	Fully opened leaves/ seedling	Leaf length (mm)	Roots/ seedling	Root length (mm)	Root colour	Biomass/ plant (mg)	Seedling growth (mg/plant/ fortnight
No fertilizer	96	16.1	3.1	21.3	5.3	11.5	White	393	9.3
100 kg N + 50 kg P_2O_5+50 kg K_2O/ha (2 DBS)	96	35.6	6.3	51.5	26.1	35.7	Brownish white	974	15.2
50 kg P_2O_5 and K_2O/ha as basal + 100 kg N/ha (10 DBPS)	96	29.5	5.6	45.8	21.5	30.2	Brownish white	829	11.3
Crotolaria verrucosa (5 tonnes/ha)	94	38.2	6.2	58.7	24.8	29.4	Pale brown	987	18.5
Casia angustifolia (5 tonnes/ha)	93	34.7	5.7	52.4	19.4	28.3	Yellow brown	948	14.4
Calotropis gigantea (5 tonnes/ha)	95	36.3	5.5	56.1	22.7	31.8	Yellow	962	15.8
Croton sparciflorus (5 tonnes/ha)	58	25.4	4.2	39.3	16.6	19.5	brown	635	10.2
Jatropha curcas (5 tonnes/ha)	89	32.1	5.1	49.2	17.3	25.3	Dark brown	936	13.2
CD (P = 0.05)	6.8	5.8	0.7	5.5	3.4	6.1		37	2.8

DBS, Days before sowing; DBPS, days before pulling seedlings
* All green-leaf manures were ploughed 5 days before sowing

rate of seedling was noticed in *Crotolaria verrucosa*-treated plots which was on par with *Casia angustifolia* and *Calotropis gigantia* green-leaf incorporation. Among green-leaf manuring, *Croton sparciflorus* inhibited the growth of rice seedlings in terms of germination and biomass. Rice (1984) opined that some weeds produce allelopathy by liberating alkaloides, phenols and amino acids during the process of decomposition. The seedlings were shorter and had few thin roots in *Croton sparciflorus*-treated plots possibly due to presence of phenolic acids in the soil (Marsie and Singh, 1988).

In general, green-leaf manuring with indigenous weeds greatly improved the seedling growth due to nutrient enrichment of soil. Infact, succulent green leaf weeds undergo rapid decomposition and mineralize 80% N within 10 days. The released N in synchrony with seedling demands and held as NH_4+ on exchange complex (Palm and Sanchez, 1991). Better root proliferation of seedlings might be due to build up of better soil structure which provides better environment for root development (Gupta and Nagarajurao, 1982). Longest roots with *Crotolaria verrucosa* may be attributed to the actions of polysaccharides and fulvic acid component in the soil medium (Yadvinder Singh *et al.*, 1991).

Fertilized seedlings attained greater heights and produced more foliage and biomass and became autotrophic earlier than unfertilized ones. The dwarf seedlings of unfertilized plots have a disadvantage under flood situation which may likely die under anoxic conditions.

Seedling output and weed growth

The seedling output/bed was greatly influenced owing to fertilization of nursery (Table 3). Interestingly, the legume weed *Crotolaria verrucosa*-treated plots yielded 2.15 times more seedling bundles than unfertilized plots. Although incorporation

Table 3. Seedling output, damage, pulling time and weed growth as affected by nursery fertilization (mean data of 2 years)

Treatment	Bundles, each of 200 seedlings (number)	Damaged seedlings (%)	Pulling time (labour/hr)	*Echinochloa glabrescensce* (No/m^2)	Seedling establishment in main field (days)
No fertilizer	105	35.5	12.8	32	5
100 kg N+50 kg P_2O_5+50 kg K_2O ha (2DBS)	211	6.2	6.9	37	6
50 kg P_2O_5 and K_2O/ha as basal+100 kg N/ha (10 DBPS)	178	8.7	8.5	39	14
Crotolaria verrucusa (5 tonnes/ha)	226	5.8	6.7	5	6
Casia angustifolia (5 tonnes/ha)	214	6.9	7.8	6	7
Calotropis gigantea (5 tonnes/ha)	220	6.1	7.2	4	7
Croton sparciflorus (5 tonnes/ha)	165	27.4	10.3	2	11
Jatropha curcas (5 tonnes/ha)	203	9.5	9.4	6	7
CD (P=0.05)	11.8	4.1	2.9	8.3	5.4

Table 4. Rice yield and yield components as influenced by nursery manuring (mean data of 2 years)

Treatment	Panicles/ m^2	Filled spikelets/ panicle	Harvest index (%)	LAI at flowering	Tiller-panicle conversion index (TPCI)	Grain yield (q/ha)		
						1995	1996	Mean
No fertilizer	395	80	47.3	3.24	73	43.1	49.5	46.3
100 kg N+50 kg P_2O_5+50 kg K_2O/ha (2 DBS)	419	92	51.8	4.21	80	48.7	54.3	51.5
50 kg P_2O_5 and K_2O/ha as basal + 100 kg N/ha (10 DBPS)	405	85	47.6	1.02	76	46.2	53.4	49.8
Crotolaria verrucosa (5 tonnes/ha)	421	91	51.7	4.35	81	48.5	56.3	52.4
Casia angustifolia (5 tonnes/ha)	416	87	50.5	4.13	77	47.6	53.0	50.3
Calotropis gigantea (5 tonnes/ha)	408	86	51.3	4.16	79	48.3	54.9	51.6
Croton sparciflorus (5 tonnes/ha)	402	82	48.5	3.95	73	45.8	50.6	48.2
Jatropha curcas (5 tonnes/ha)	407	85	50.4	4.03	75	46.9	52.5	49.7
CD (P = 0.05)	12.5	5.8	4.3	0.95	6.7	2.4	4.5	4.1

of *Croton sparciflorus* produced 36.4% more seedling bundles, but it was 27% lesser than *Crotolaria* verrucosa. This may be ascribed due to lesser seed germination and more damaged seedlings while uprooting. Further, pulling of seedlings was easy in case of fertilized plots irrespective of its source. The roots were held loosely with soil particles and made pulling easy with less damage to seedlings. Unfertilized seedlings were too short to be pulled from soil, resulting in poor output of bundles.

The mimitic weed, *Echinochloa glabrescense* emerged in large number both in the control and inorganic-fertilized plots. Green-manured plots conspicuously suppressed the weed population to an extent of 8.2% – 93.7%. The results are in line with findings of Olofosdotter (1998).

Unfertilized sedlings established very quickly in the main field due to nutritional hunger in nursery. Seedlings received N top-dressing at 10 days before planting showed the leaf withering and mortality and took 14 days for establishment. In fact, the accumulation of intermediate N compounds like hyponitrite and nitrates in plant tissues are toxic in the absence of sufficient sugars when the seedlings are transplanted in the new environment. Devlin (1990) also expressed similar view. Seedlings received basal N and green-leaf manuring, did not show leaf injury after transplanting indicating that absorbed N might have been transaminated into protein bodies by the time of transplanting. Thus seedlings with basal N applications of nutrients either organic or inorganic were found to be better compared to no or top-dressed.

Yield and yield components

Nursery fertilization markedly influenced the yield and yield components of rice significantly (Table 4). Highest grain yield was obtained in plots which received *Crotolaria verrucosa* green-leaf manuring and it was 11.6% more than unfertilized seedlings. All green leaf weeds and inorganic fertilizers almost equally influenced the yields. However, seedlings raised with green leaf of *Croton sparciflorus* registered 11.6% lesser yield compared with *Crotolaria verrucosa*.

Thus nursery fertilization is essential for getting robust seedlings and more seedling output which ultimately gives higher harvests of rice. The wasteland weeds *Crotolaria verrucosa, Cassia angustifolia, Calotropis gigantea* and *Jatropha curcas* can be used as green-leaf manures successfully to realize better yields without investing on costly industrial fertilizers. The abundant and renewable natural weed vegetation may be used as effective source of nutrients in future rice culture.

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