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Evaluation of different weed management practice on growth and yield attributing characters of rice under direct seeded rice system

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Abstract
A field experiment was conducted at Agronomy farm, School of Agricultural Science and Rural Development (SASRD), Nagaland University, Medziphema campus during rainy season of the 2014. Twelve weed control treatments were tested in randomized block design replicated thrice. Result showed that growth and yield attributes parameters and weed dynamics were significantly affected and trend of higher production and lower weed dynamics in different growing stages of direct seeded rice was obtained. Among the weed management practices, Bispyribac Sodium salt @ 250 ml/ha POE at 15 DAS+1Hand weeding at 30 DAS was found the best for obtaining higher production (3.25 t/ha) and highest weed control efficiency (91.48) at 50 DAS. Among the weed control practices, Stale seed bed technique followed by Bispyribac Sodium salt @ 250 ml/ha. POE at 15 DAS was found the best for obtaining higher net profit (Rs/ha 34689.5) and Benefit cost ratio (1.40) in different weed management practices under direct seeded rice system.

Keywords: DSR, stale seedbed technique, plastic mulching, brown mannuring

Introduction
Rice (*Oryza sativa* L.) is one of the most important food crop in the world of being staple food for more than 3 billion people. In world, area of rice is 159.30 million hectares with production of 474.60 million metric tonnes (Anonymous, 2015). During the year 2015, India produced 102.50 million metric tonnes of rice from 43 million hectare of the land (Anonymous, 2015).Direct seeded rice, a common practice before green revolution in India, is becoming popular once again because of its potential to save water and labour (Gupta *et al.* 2006). Currently, direct seeded rice in Asia occupies about 29 Million hectare which approximately 21% of the total rice area in the region. Countries like USA and Australia extensively practicing direct seeding of rice are with profitable results as it avoids all the penalties entailed in transplanting.In Nagaland, rice is the for most cereal crop of the people with about 70 per cent of the population directly or indirectly engaged in agriculture. The total rice cultivation accounts to an area of 4,117.0 hectares and producing 405.2 tonnes of paddy (Anonymous, 2013). It is grown under varying agro climatic condition rain fed upland / jhum land, rain fed, lowland / waterlogged area, wet paddy lands terraces with irrigation facility etc. Direct seeded rice under no/reduced tillage is an efficient resource conserving technology holding good promise in coming days because of the following advantages over transplanting of rice such as (1) Labour required for nursery raising (2) Uprooting and transplanting of seedlings are saved to the extent of about 40% (3) Saving of water (up to 60%) as nursery raising (4) Puddling, seepage and percolation are eliminated (5) Fertilizer use efficiency is increased because of placement/application of fertilizer in the root zone (6) Early maturity (7-10 days) helping in timely sowing of succeeding crops (7) Energy saving (up to60% of diesel) because of elimination of field preparation for nursery raising (8) puddling and reduced water application for irrigation (9) Reduction in methane emission and global warming potential. Soil structure is not disturbed in direct seeded rice as occurs in puddle transplanted system. Less drudgery to farm women labours because of elimination of transplanting. System productivity is enhanced and Cost of cultivation is reduced by about 5000-6000 Rs ha^{-1}. In direct-seeded rice culture, weeds are the biggest constraint; because of the absence of flooding during early stages, all types of weeds such as grasses, non-grasses, and sedges emerge simultaneously at high density with rice seedlings. Ultimately it reduces up to 40-100% yield in direct seeded upland rice. The weed presence is higher in dry direct-seeded culture than in wet direct-seeded and transplanted rice cultures mainly because of differences in land preparation.

The use of only one method of weed control in a direct-seeded rice crop may not be successful for raising a good crop. Various methods such as cultural practices and manual, mechanical, and chemical methods should be carried out together.

Materials and methods

Field experimental was conducted at School of Agricultural Science and Rural Development (SAARD), Nagaland University, Medziphema Campus during rainy season of the 2014 to study the Response of rice (*Oryza sativa* L.) to different weed management practices under direct seeded rice system. The soil of the before experiment field was sandy loam, well drained with strong acidic pH (4.7), high organic carbon (1.67%), medium in available nitrogen (281.21 kg ha^{-1}), low in available phosphorus (16 kg ha^{-1}) and medium in available potassium (257.37 kg ha^{-1}) in randomized block design (RBD) with three replication to evaluate effectiveness of different weed management practices; weedy, weed free, other ten practices with Farmer's Practices, Two Hand weeding at 15 DAS and 30 DAS, 2, 4-D Amine salt @ 1 lit/ha at 30 DAS, One Hand weeding at 15 DAS + 2, 4-D Amine salt 1 lit/ha at 30 DAS, Bispyribac Sodium salt @ 250 ml/ha POE at 15 DAS, Bispyribac Sodium salt @ 250 ml/ha POE at 15 DAS+1Hand weeding at 30 DAS, Glyphosate @ 2 lit/ha at 30 DAS, Stale seed bed technique followed by Bispyribac Sodium salt @ 250 ml/ha POE at 15 DAS, Brown Manuring followed by 2, 4-D @1lit/ha at 30 DAS, Plastic mulching up to 50 DAS on the performance of direct seeded rice.Leikhumo is a popular local rice cultivar (130-140) days to mature in Nagaland was sown during rainy season 31/05/2014 with spacing 20*10 (cm). The crop was well decomposed FYM (10-12 tonnes per hectare) was broadcasted over the field during land preparation. A recommended dose of 60 Kg of N, 30 Kg P_2O_5 and 30 Kg of K_2O/ha of which half dose of nitrogen and full dose of phosphorus and potassium in the form of urea, single super phosphate(SSP) and muriate of potash (MOP) as basal dose were incorporated in the soil. Remaining quantity of nitrogen was applied at tillering and panicle initiation stages. The data on weed intensity (50 DAS) and weed dry weight (50 DAS) were recorded with the help of a quadrate (0.5 x 0.5 m). In case of observation on weeds, normality of distribution was not seen and hence, the values were subjected to square root transformation ($\sqrt{X+0.5}$) prior to statistical analysis to normalize their distribution. Observations on crop growth parameters, *viz* plant height (cm), number of tillers $plant^{-1}$, number of effective grains $panicle^{-1}$, test weight, grain yield were recorded.

Results and discussion

Weed flora

The dominant weed species *Brachiaria reptans* (Linn.), *Cynodon dactylon* (Linn.), *Digitaria sanguinalis* (Linn.), *Echinochloa crusgalli* (Linn.), *Eleusine indica* (Gaertn.), *Oplissuenus conspos* and *Poa annua* (Linn.) in grassy weeds, *Ageratum conyzoides* (Linn.), *Amaranthus viridis* (Linn.) *Bidens pilosa* (Linn.), *Borreria hispidia, Cassia tora* Linn., *Clrena lobata, Chromoleana odorata, Commelina benghalensis* Linn., *Ipomoea hispidia* Roem. & Sch., *Leucas aspera* (Willd) Spreng., *Mimosa spinosa, Portulaca oleracea* Linn., *Sida acuta* Linn. and *Sida cordifolia* Linn in broad leaved weeds and *Cyperus rotundus* (Linn.) and *Cyperus irria* (Linn.) in sedge during experimental field. These weeds were associated with the crop throughout the growing season of data recording.

Weed growth

The weed intensity and weed dry weight of weeds were significantly reduced by all treatments and hand weeding over weedy check 9.26 $no.m^{-2}$ (W_2). The significantly lowest weed intensity $no.m^{-2}$ (3.89) was recorded under Bispyribac Sodium salt @ 250 ml *a.i.* ha^{-1}POE at 15 DAS + 1Hand weeding at 30 DAS (W_8) followed by Stale seed bed technique followed by Bispyribac Sodium salt @ 250 ml *a.i.* ha^{-1} POE at 15 DAS (W_{10}) and Bispyribac Sodium salt @ 250 ml *a.i.* ha^{-1} POE at 15 DAS (W_7) registered reduce the weed density. The highest dry weight of weed was recorded from W_2 (731.81). The lowest dry weight of weed was recorded in W_8 (62.29) which were at par with two hand weeding at 15 DAS and 30 DAS (W_4), one hand weeding at 15 DAS + 2, 4-D Amine salt 1 lit *a.i.* ha^{-1} at 30 DAS (W_6), Stale seed bed technique followed by Bispyribac Sodium salt @ 250 ml *a.i.* ha^{-1} POE at 15 DAS (W_{10}), Bispyribac Sodium salt @ 250 ml *a.i.* ha^{-1} POE at 15 DAS (W_7) and 2, 4-D Amine salt @ 1lit *a.i.* ha^{-1} at 30 DAS (W_5) significantly superior over the rest of treatments. These indicates that application of bispyribac sodium salt @ 250 ml *a.i.* ha^{-1} Post emergence at 15 DAS + One hand weeding at 30 DAS (W_8). The control of weed due to the application of post emergence bispyribac sodium salt at 15 DAS and also due to weeds at later stage was achieved by hand weeding at 30 DAS. Bhurer *et al.* (2012) also reported that the weed control by post emergence bispyribac sodium salt @ 25 g *a.i.* ha^{-1} at 15 DAS + One hand weeding at 35 DAS.

Weed control efficiency (%)

Significant differences in weed control efficiency were recorded due to different weed management practices under DSR treatments at 50 DAS. The highest weed control efficiency (91.48) was recorded from bispyribac sodium salt @ 250 ml *a.i.* ha^{-1} POE at 15 DAS + One hand weeding at 30 DAS (W_8) followed by two hand weeding at 15 DAS and 30 DAS (W_4), one hand weeding at 15 DAS + 2, 4-D Amine salt 1 lit *a.i.* ha^{-1} at 30 DAS (W_6), Stale seed bed technique followed by Bispyribac Sodium salt @ 250 ml *a.i.* ha^{-1} POE at 15 DAS (W_{10}). The lowest weed control efficiency (7.22) was found in weedy check W_2.

Crop growth

All growth parameters *viz* plant height and numbers of tillers per plant were significantly influenced by all weed control treatments plant height at harvest and numbers of tillers per plant all crop growth stages except 30 DAS. The effect of different weed management practices on plant height showed highly significant at harvest in Bispyribac Sodium salt @ 250 ml *a.i.* ha^{-1}POE at 15 DAS + 1Hand weeding at 30 DAS (W_8), Two Hand weeding at 15 DAS and 30 DAS (W_4), Stale seed bed technique followed by Bispyribac Sodium salt @ 250 ml *a.i.* ha^{-1} POE at 15 DAS (W_{10}) and One hand weeding at 15 DAS + 2, 4-D Amine salt 1 lit *a.i.* ha^{-1} at 30 DAS (W_6) were found most effective treatments to enhance the plant height, number of tillers $plant^{-1}$, leaf area index, dry weight of plant g running m^{-1}. This may be because of the fact that there was very little crop-weed competition for different growth factors under these treatments as these recorded lowest population of narrow, broadleaved weeds and sedges weeds species as well as lowest weed dry weight, which provided better opportunity to the crop to utilize nutrients, moisture, light and space in better way for its proper growth and development. This may also be due to the fact that the plants under less crop-weed competition had more vertical and horizontal growth as a result, these treatments recorded more plant height and

numbers of tillers per plant as compared to other treatments. These finding are in line with Bhurer *et al.* (2012) who reported that application of herbicide significantly increased plant height and numbers of tillers per plant over weedy check.

Yield attributing characters

Yield attributing characters *viz* numbers of effective grains panicle^{-1} and test weight (g) were significantly influenced by different weed control management practices under DSR. All these yield attributing characters were significantly increased over weed check by all weed control treatments (Table 1). The highest number of grains panicle^{-1} which was at par with W_8, W_{10}, W_4 and W_{12} significantly superior over the rest of the treatments. However they were all superior over the weedy check (W_2) which recorded the lowest number of grains panicle^{-1}. This was due to the fact because of reduced competition from weeds due to the weed management measures plant utilized the growth factors in more efficient manner which was ultimately reflected in increased number of grains panicle^{-1}. Bhurer *et al.* (2012) also reported from post emergence Bispyribac 25 *a.i.* ha^{-1} at 15 DAS followed by one hand weeding at 35 DAS and Bhurer *et al.* (2013) recorded from stale seedbed followed by bispyribac. Weed free (W_1) recorded the maximum test weight and at par with W_8, W_{10}, W_4, W_6, W_{12}, W_5, W_7 and W_9. Weed check (W_2) recorded the lowest test weight and was statistically inferior to all the other weed management treatments. This might be due to elimination of weed competition to a great extent by Bispyribac Sodium salt @ 250 ml *a.i.* ha^{-1} POE at 15 DAS + One hand weeding at 30 DAS. Bhurer *et al.* (2012) and Bhurer *et al.* (2013) also reported that the highest test weight was recorded in weed free by repeated hand weeding and lowest in weed check.

Grain yield

The grain yield recorded under the different weed management practices under DSR showed significant differences. The grain yield ranges from 1.22 t ha^{-1} to 3.25 t ha^{-1}. Among all the weed management practices W_1 produced significantly highest yield (3.25 t ha^{-1}) over the rest of the treatments, however it was being at par with the bispyribac sodium salt @ 250 ml *a.i.* ha^{-1} POE (3.05 t ha^{-1}) at 15 DAS + One hand weeding at 30 DAS (W_8) and stale seed bed technique (3.02 t ha^{-1}) followed by bispyribac sodium salt @ 250 ml *a.i.* ha^{-1} POE at 15 DAS (W10). The lowest grain yield (1.22 t ha^{-1}) was found to be associated with weed check (W_2). Weed free treatment W_1, yield was increased by 62.46 %, due to the regular weeding and the reason decrease in weedy check (166.39 %) was that no cultural practiced was done. Bhurer *et al.* (2012) and Bhurer *et al.* (2013) also reported number of panicles m^{-2} and number of filled grain panicles^{-1} were highly correlated with grain yield. The highest grain yield was recorded with application of bispyribac sodium salt @ 250 ml *a.i.* ha^{-1} POE at 15 DAS + One hand weeding at 30 DAS (W_8). This result is in agreement with that of Bhurer *et al.* (2012) who reported that application of bispyribac sodium salt @ 250 ml *a.i.* ha^{-1} POE at 15 DAS + One hand weeding at 30 DAS (W_8) gave higher grain yield. Weed check (W_2) recorded the lowest grain yield. This may be due to severe crop weed competition.

Economics

The choice of any weed control method ultimately depends on economics and efficiency in controlling weeds (Table 1) the cost of chemical weed control is actually less than that of manual weeding. This has been a major incentive to many farmers for switching over to herbicides of the different weed control management practices under DSR. The highest net profit Rs 34,685.5 was obtained with the application of stale seed bed technique followed by bispyribac sodium salt @ 250 ml *a.i.* ha^{-1} POE at 15 DAS (W_{10}) on the other hand there was a negative balance of Rs -401470 which was recorded from the plastic mulching up to 50 DAS. Among the all different weed management practices under DSR treatments the highest net return from stale seed bed technique followed by bispyribac sodium salt @ 250 ml *a.i.* ha^{-1} POE at 15 DAS (W_{10}) probably because of less cost of cultivation and good production grain and straw yield. The highest benefit cost ratio (1.40) observed in case of the treatment stale seed bed technique followed by bispyribac sodium salt @ 250 ml *a.i.* ha^{-1} POE at 15 DAS (W_{10}) whereas, the lowest benefit ratio (-0.88) was recorded under the treatment plastic mulching up to 50 DAS (W_{12}).Among the all different weed management practices under DSR treatments the highest net return from stale seed bed technique followed by bispyribac sodium salt @ 250 ml *a.i.* ha^{-1} POE at 15 DAS (W_{10}). This was due to highest net return and average cost of cultivation. This result collaborated with Bhurer *et al*. (2013) also found that in stale seedbed followed by bispyribac.

Table 1: Effect of different weed management practices on weed intensity (no.m^{-2}), dry weight of weeds (g m^{-2}), weed control efficiency (%), crop growth, yield (t ha^{-1}) and economics of direct seeded rice system.

Treatments	Weed growth			Crop growth and yield					Economics	
	Weed intensity at 50 DAS	Dry weight of weeds at 50 DAS	WCE (%)at 50 DAS	Plant height at harvest (cm)	No. of tillers plant^{-1}	No. of effective grains panicle^{-1}	Test weight (g)	Grain yield (t ha^{-1})	Net Profit (Rs ha^{-1})	B:C
W_1 Weed free	0.71 (0.00)	0.71 (0.00)	100	127.67	7.07	163.40	21.67	3.25	22282.5	0.55
W_2 Weedy check	9.26 (27.78)	25.63 (731.81)	-	111.93	3.27	64.33	20.14	1.22	4614.05	0.22
W_3 Farmer's Practices (Common salt @ 200 kg ha^{-1})	7.34 (22.01)	24.53 (678.97)	7.22	117.40	3.87	94.67	20.44	1.48	6630.5	0.28
W_4 Two Hand weeding at 15 DAS and 30 DAS	6.28 (18.83)	8.94 (114.14)	84.40	126.93	6.33	144.80	21.33	2.73	26070.5	0.90
W_5 2, 4-D Amine salt @ 1lit *a.i.* ha^{-1} at 30 DAS	6.75 (20.25)	16.69 (305.62)	58.23	118.00	4.07	105.67	20.72	1.56	10248.5	0.47
$W_6$1 Hand weeding at 15 DAS + 2, 4-D Amine salt 1 lit *a.i.* ha^{-1} at 30 DAS	5.48 (16.44)	11.36 (151.78)	79.25	122.93	5.87	116.73	21.28	2.13	18760.5	0.73
W_7 Bispyribac Sodium salt @ 250 ml *a.i.* ha^{-1} POE at 15 DAS	4.20 (12.59)	13.97 (195.12)	73.12	121.07	5.53	129.20	20.66	2.15	19337.5	0.81
W_8 Bispyribac Sodium salt @ 250 ml *a.i.* ha^{-1}POE at 15 DAS + 1Hand weeding at 30 DAS	3.89 (11.68)	7.69 (62.29)	91.48	127.40	6.87	154.80	21.50	3.05	32177.5	1.16
W_9 Glyphosate @2 lit *a.i.* ha^{-1}at 30 DAS	7.27 (21.82)	24.27 (593.63)	18.88	122.07	4.27	129.20	20.53	1.90	19398.5	0.88
W_{10} Stale seed bed technique followed by Bispyribac Sodium salt @ 250 ml *a.i.* ha^{-1} POE at 15 DAS	4.01 (12.04)	12.98 (179.03)	75.53	123.47	6.07	150.33	21.36	3.02	34685.5	1.40
W_{11} Brown Manuring followed by 2, 4-D @1lit *a.i.* ha^{-1} at 30 DAS	5.16 (15.48)	23.74 (585.48)	19.99	121.67	4.27	113.60	21.14	2.36	26148.5	1.19
W_{12} Plastic mulching up to 50 DAS	6.01 (18.02)	21.11 (500.17)	31.65	122.93	5.27	143.80	21.16	2.68	-401470	-0.88
S.Em (±)	0.28	3.20		2.41	0.39	6.49	0.39	0.08		
CD at 5%	0.84	9.60		7.23	1.16	19.46	1.18	0.24		

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