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Effect of combined application of fertilizers and herbicides on drum seeded rice

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Abstract
A field experiment was conducted at Tamil Nadu Agricultural University, Agricultural College and Research Institute in Madurai, Tamil Nadu during summer 2022 to study the compatibility of urea, DAP and herbicides as filler materials with paddy seeds (pre-germinated and dry) in drum seeder. The experiment was laid in Factorial Randomized Block Design (FRBD) with sixteen treatments and three replications. ADT 55 was the used as test variety in the experiment. From the study, it was observed that, seeds + Urea + DAP + herbicide (Bensulfuron methyl 0.6% + Pretilachlor 6%) recorded higher growth attributes like plant height of 104.9 cm, root volume of 41.1 cc and 484 tillers per m^2 at harvest stage.

Keywords: Pre-germinated seeds, dry seeds, filler materials, herbicide

1. Introduction
Rice is one of the most significant crops of India and cultivated in 45.1 million hectares yielding 122.27 million tonnes (Indiastat, 2020-21). In Tamil Nadu, it is grown in 1.90 million hectares with production and productivity of 7.17 million tonnes and 3.76 t ha^{-1} respectively (Indiastat, 2019 - 20). Rice is established through direct seeding or transplanting. Labour shortage during peak season, increasing labour costs, lack of adequate water and other inputs are the major issues faced by the farmers for raising nursery and transplanting. Direct seeding of rice is found to be the most effective alternative to transplanting to address these issues. It not only eliminates seedbed preparation, raising of nursery and transplanting, but also produces a higher yield than conventional transplanting. As a result, direct seeding is becoming increasingly common in India these days. Direct seeding can be further divided into two types: broadcasting and row sowing with a drum seeder. The eight-row paddy seeder is a low-cost, manually operated machine for direct seeding. Weed infestation is one of the major issues in rice which cause severe yield losses to the tune of 50.4 to – 80 per cent (Mahajan and Chauhan, 2015; Parthipan and Ravi, 2016) [9, 11] and reduced benefit cost ratio by 60.7 per cent (Riaz *et al*., 2018). Weeds remove approximately 367.8, 220.0 and 291.0% of N, P and K from rice field (Raj and Syriac, 2017) [13]. Herbicide based weed control is the best choice for weed management in rice due to labor scarcity with high wage rate (Singh *et al*., 2006) [14]. Moreover, application of herbicides in rice remarkably suppressed the growth of weeds (Kaur *et al*., 2019 and Dangol *et al*., 2020) [8, 4]. The use of fertilizer with herbicides can perform either negative or positive action on their strength (Bernards *et al*., 2005) [2]. In this context, no reduction in herbicidal efficiency was obtained as a result of the concurrent use of fertilizers (copper, iron, manganese and magnesium) and herbicides (Makvandi *et al*., 2007) [10]. Adding manganese to herbicide solution of glyphosate caused reduction in controlling several weed types (Bailey *et al*., 2002; Bernards *et al*., 2005) [1, 2]. A synergistic influence on crop yield could be achieved due to integrated effect of herbicide and nutrient applications (Gauvrit, 2003) [5]. Unlike, mixing nitrogen and boron with glyphosate did not possess baneful effect on growth target weeds (Scroggs *et al*., 2009) [15]. Nevertheless, knowledge on the effect of co–application of rice herbicides and plant nutrients on weed control is so limited. The controversy about the type of interference (synergism or antagonism) between herbicides and nutrients is one of the major concerns in rice production. Also, crop safety to combination of herbicides and nutrients is another concern. The current study hypothesizes that plant nutrition and herbicide application may have interactive impacts on weed growth and rice yield. Therefore, the present research was aimed to (a) to investigate the compatibility of urea, DAP and herbicides as filler materials with both the pre-germinated and dry seeds of paddy and (b) to study the effect of treatments on growth and yield of rice.

2. Materials and Methods

A field experiment was carried out at Agricultural College and Research Institute, Madurai (9°54' N, 78°54' E), Tamil Nadu during 2022. The experimental site is located in a semi-arid tropical zone. The soil texture in the experimental field is sandy clay loam. The treatment comprised of two factors *viz.*, factor 1: Seed treatments and factor 2: Fertilizers and herbicide as filler materials. The treatments were S_1F_1 - pre-germinated seeds + Urea, S_1F_2 - pre- germinated seeds +DAP, S_1F_3- pre- germinated seeds +Urea + DAP, S_1F_4 pre-germinated seeds +Urea + Bensulfuron methyl 0.6% + Pretilachlor 6%, S_1F_5- pre- germinated seeds +DAP + Bensulfuron methyl 0.6% + Pretilachlor 6%, S_1F_6- pre-germinated seeds + Urea + DAP+ Bensulfuron methyl 0.6% + Pretilachlor 6%, S_1F_7- pre- germinated seeds alone + soil application of fertilizers and Bensulfuron methyl 0.6% + Pretilachlor 6%, S_1F_8- pre- germinated seeds alone + soil application of fertilizer alone, S_2F_1 - dry seeds + Urea, S_2F_2 - dry seeds seeds +DAP, S_2F_3- dry seeds +Urea + DAP, S_2F_4 dry seeds +Urea + Bensulfuron methyl 0.6% + Pretilachlor 6%, S_2F_5- dry seeds +DAP + Bensulfuron methyl 0.6% + Pretilachlor 6%, S_2F_6- dry seeds + Urea + DAP+ Bensulfuron methyl 0.6% + Pretilachlor 6%, S_2F_7- dry seeds alone + soil application of fertilizers and Bensulfuron methyl 0.6% + Pretilachlor 6%, S_2F_8- dry seeds alone + soil application of fertilizer alone. All the treatments were imposed as per the schedule and all the crop management practices were followed as per the Crop Production Guide, 2021. At 7 DAS, the phytotoxic effect of various treatments on rice seedlings was observed using a simple rating scale of 0 to 10 (equal to 0 to 100%) as suggested by Rao 2000. Growth parameters like plant height, number of tillers m^{-2}, root length and root volume were taken and analyzed statistically using standard procedures given by Gomez and Gomez, 1984 [6].

3. Results and discussion

3.1. Phototoxic scoring (Appendix 1)

Combined application of fertilizers and herbicides along with the rice seeds did not show any phytotoxicity symptoms on rice seedlings. The phytotoxicity effect on rice has been rated from "none to slight". Discolouration of leaves was observed in Urea + DAP (F_3) & Urea + DAP+ Bensulfuron methyl 0.6% + Pretilachlor 6% (F_6) with both pre germinated (S_1) and dry (S_2) seeds. However, the plants got recovered from discoloration within three days on their own without any external inputs (Table 1).

Table 1: Visual scoring of phytotoxic effect on rice seedlings

Treatments	Level of phytotoxicity	Scale
S_1F_1	None	0
S_1F_2	None	0
S_1F_3	Slight	1
S_1F_4	None	0
S_1F_5	None	0
S_1F_6	Slight	1
S_1F_7	None	0
S_1F_8	None	0
S_2F_1	None	0
S_2F_2	None	0
S_2F_3	Slight	1
S_2F_4	None	0
S_2F_5	None	0
S_2F_6	Slight	1
S_2F_7	None	0
S_2F_8	None	0

3.2. Plant height (cm)

The results of the experiment showed that there was no significant difference in plant height between pre germinated and dry seeds. With regard to filler materials, the taller plants of 57.9, 73.9 and 104.9 cm was noticed with urea + DAP + Bensulfuron methyl 0.6% + Pretilachlor 6% (F_6) at active tillering, panicle initiation and harvest stage, respectively. This may be due to the synergetic effect of basal application of fertilizers and herbicide which would have minimized the weed population resulting in reduced crop weed competition which might have increased the plant height (Saudy *et al.*, 2021) [16]. It was followed by seeds alone + soil application of fertilizers and Bensulfuron methyl 0.6% + Pretilachlor 6% (F_7) with the plant height of 54.2, 69.8, 99.1cm at active tillering, panicle initiation and harvest stage, respectively. The shorter plants of 34.9, 48.1 and 66.3 cm was registered with seeds + soil application of fertilizer alone (F_8) at active tillering, panicle initiation and harvest stage, respectively. There was no interaction between the seeds and filler materials. (Table 2).

Table 2: Influence of filler materials on plant height of rice (cm)

Treatments	Active tillering			Panicle initiation			Harvesting		
	S_1	S_2	Mean	S_1	S_2	Mean	S_1	S_2	Mean
F_1	38.7	38.0	38.4	52.2	51.5	51.9	72.0	71.7	71.9
F_2	42.0	41.3	41.7	55.8	55.1	55.5	77.5	77.2	77.4
F_3	45.0	44.3	44.7	59.3	58.7	59.0	83.2	82.7	83.0
F_4	48.2	47.4	47.8	62.8	62.1	62.5	88.5	88.1	88.3
F_5	51.3	50.6	51.0	66.4	65.9	66.2	93.9	93.6	93.8
F_6	58.1	57.6	57.9	74.1	73.6	73.9	105.2	104.6	104.9
F_7	54.5	53.8	54.2	70.1	69.4	69.8	99.4	98.8	99.1
F_8	35.2	34.5	34.9	48.4	47.7	48.1	66.4	66.1	66.3
Mean	46.6	45.9		61.1	60.5		85.8	85.4	
	S	F	S×F	S	F	S×F	S	F	S×F
SEd	0.72	1.44	2.03	0.8	1.6	2.26	1.24	2.49	3.52
CD(p=0.05)	NS	2.94	NS	NS	3.26	NS	NS	5.09	NS

3.3. Root volume (cc)

There was no significant difference between seed soaking and dry seeds with respect to root volume. As regards to filler materials, the maximum root volume of 33.1, 38 and 41.1 at active tillering, panicle initiation and harvest stage was recorded with seeds + urea + DAP + Bensulfuron methyl 0.6% + Pretilachlor 6% (F_6). This may be due to the profused root growth as influenced by the spot placement of nutrients and herbicide along with seeds (Gauvrit, 2003) [5] which ensured healthy root system which would have facilitated uptake of more nutrients from the soil. This was followed by seeds alone + soil application of fertilizers and Bensulfuron methyl 0.6% + Pretilachlor 6% (F_7) with the root volume of 29.9, 35.5, and 38.9 during active tillering, panicle initiation and harvest stage. The minimum root volume of 13.6, 20.3 and 26.4 at active tillering, panicle initiation and harvest stage was noticed with seeds + soil application of fertilizer alone (F_8). There was no interaction between the seeds and filler materials. (Table 3) and (Fig.1).

Table 3: Influence of filler materials on root volume of rice (cc)

Treatments	Active tillering			Panicle initiation			Harvesting		
	S1	S2	Mean	S1	S2	Mean	S1	S2	Mean
F1	16.1	15.6	15.9	23.2	22.9	23.1	28.9	28.5	28.7
F2	18.2	17.6	17.9	25.8	25.3	25.6	31	30.6	30.8
F3	20.8	20.2	20.5	28.7	28.3	28.5	33.2	32.7	33.0
F4	23.4	22.6	23.0	30.9	30.6	30.8	35.1	34.7	34.9
F5	26.7	26.5	26.6	33.2	32.8	33.0	37.1	36.7	36.9
F6	33.3	32.8	33.1	38.2	37.8	38.0	41.3	40.8	41.1
F7	30.2	29.5	29.9	35.7	35.3	35.5	39.2	38.6	38.9
F8	13.9	13.3	13.6	20.4	20.1	20.3	26.6	26.2	26.4
Mean	22.8	22.3		29.5	29.1		34.1	33.6	
	S	F	S×F	S	F	S×F	S	F	S×F
SEd	0.44	0.89	1.26	0.49	0.98	1.39	0.47	0.94	1.33
CD(p=0.05)	NS	1.82	NS	NS	2.01	NS	NS	1.92	NS

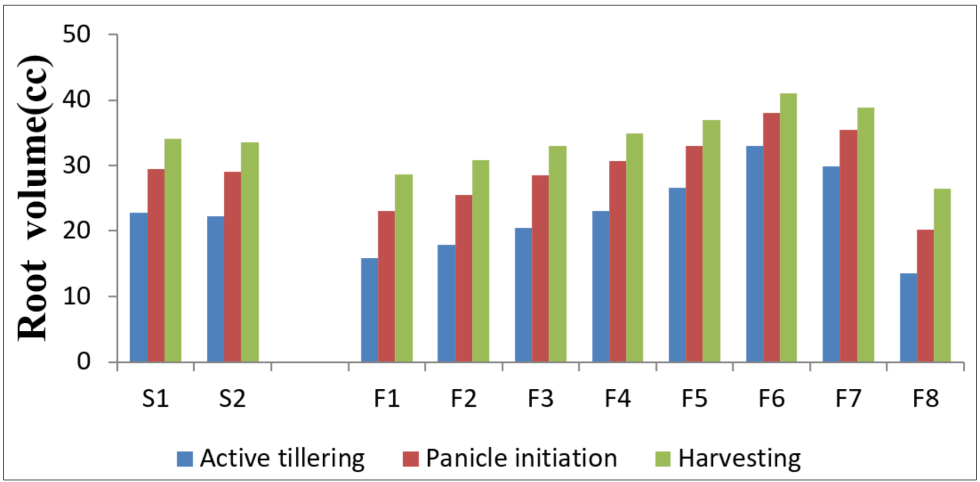

Fig 1: Influence of filler materials on root volume

3.4. Tillers per metre [2]

It was evident from the experiment; there was no significant difference between seed soaking and dry seeds on the number of tillers m^{-2}. With respect to filler materials, more number of tillers (401, 444 and 484 m^{-2}) was registered in seeds + urea + DAP + Bensulfuron methyl 0.6% + Pretilachlor 6% (F_6) at active tillering, panicle initiation and harvest stage, respectively. This may be due to weed free environment provided by the spot application of fertilizers and herbicide together with seeds which led to uptake of optimum quantity of nutrients which resulted in more number of tillers per unit area (Payman and Singh 2008) [12]. This was followed by seeds alone + soil application of fertilizers and Bensulfuron methyl 0.6% + Pretilachlor 6% (F_7) with tillers of 359, 417 and 449 at active tillering, panicle initiation and harvest stage. The minimum number of tillers (233, 265 and 271 m^{-2}) was recorded at active tillering, panicle initiation and harvest stage with seeds + soil application of fertilizer alone (F_8). Significant interaction effect was noticed in seed treatment and filler materials on of tillers m^{-2}. Dry seeds + urea + DAP + Bensulfuron methyl 0.6% + Pretilachlor 6% (S_2F_6) recorded more number of tillers of 420,471 and 487 m^{-2} at active tillering, panicle initiation and harvest stage . Less number of tillers was noticed in dry seeds + soil application of fertilizer alone (S_2F_8) with 218, 263 and 274 m^{-2} at active tillering, panicle initiation and harvesting stage, respectively. (Table 4).

Table 4: Influence of filler materials on tillers m^{-2}

Treatments	Active tillering			Panicle initiation			Harvesting		
	S1	S2	Mean	S1	S2	Mean	S1	S2	Mean
F1	261	246	253	287	292	289	295	304	299
F2	277	267	272	318	304	311	337	319	328
F3	293	283	288	348	325	337	365	352	358
F4	310	295	302	372	358	365	429	363	396
F5	336	313	325	403	380	392	418	415	417

F6	382	420	401	416	471	444	481	487	484
F7	360	358	359	428	405	417	450	447	449
F8	248	218	233	267	263	265	268	274	271
Mean	308	300		355	350		380	370	
	S	F	S×F	S	F	S×F	S	F	S×F
SEd	4.66	9.32	13.18	5.85	11.71	16.57	5.54	11.09	15.69
CD(p=0.05)	NS	19.04	26.93	NS	23.93	33.84	NS	22.66	32.05

4. Conclusion
From the results of the study, it can be concluded that combined application of nutrients and herbicide had no phototoxic effect on the emerging seedlings, rather, improved the growth attributes of rice. There was no significant difference between soaked and dry seeds on the parameters studied indicating the scope for direct seeding of dry seeds in Command areas without waiting for pre germination or nursery preparation. With regard to filler materials, there was a synergistic effect between fertilizers and herbicide ruling out the ambiguity, be it, reduced germination, impairment of young seedlings, reduced herbicidal or nutrient use efficiencies. Hence, sowing of dry seeds in combination with urea, DAP and Bensulfuron methyl 0.6% + Pretilachlor 6% (F_6) while drum seeding was found to be a viable option for higher growth attributes of rice variety, ADT 55.

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Appendix

Appendix 1: Visual rating scale for phytotoxicity

Level of phytotoxicity	Scale	Description of crop injury
None	0	No injury, normal
Slight	1	Slight stunting, injury or discolouration
	2	Some stand loss, stunting or discolouration
	3	Injury more pronounced but not persistent
Moderate	4	Moderate injury recovery possible
	5	Injury more persistent, recovery doubtful
	6	Near severe injury, no recovery possible
Severe	7	Severe injury, stand loss
	8	Almost destroyed, a few plant surviving
	9	Very few plants alive
Complete	10	Complete destruction