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Effect of Rice Allelochemical, Mulch and Herbicides on Growth of Wheat under Different Crop Establishment Methods

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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Original Research Article

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ABSTRACT

In India wheat is grown mostly after rice in Rice-wheat system, which effects the establishment of wheat crop because field requirement of both crop is different so there is need of studying other better crop establishment methods for wheat. This experiment was carried out in research farm of Banaras Hindu University, Varanasi, Uttar Pradesh in split plot design with three replication, where three different crop establishment methods i.e. conventional method, raised bed and zero-till in main plot and in subplot five different weed control practices along with control (weedy check) allotted. From the observation it found that plant height of crop was significantly higher in zero-till plot than conventional and raised bed method. Among weed management practices rice residue as mulch @ 4 t ha-1 fb clodinofop propargyl + metsulfuron @ 100% of recommended dose (2-4 leaf stage of weed), Clodinofop propargyl @ 60g a.i. ha-1 + metsulfuron @ 4g a.i. ha-1 , Rice residue as mulch @ 4 t ha-1 fb rice extract (10gL-1) at 2-4 leaf stage of weed , two hand weeding at 20 and 40 DAS, Clodinofop propargyl @ 75% of recommended dose + rice extract (10gL-1) at 2-4 leaf stage of weed gave significantly higher plant height than weedy check plot. For higher yield, growth of crop must be enhanced so it's better to go for zero-till sowing for wheat than conventional method.

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1. INTRODUCTION

Wheat is the most important food-grain of India next to rice and is the staple food of millions of Indians, particularly in the northern and north-western parts of the country. It is rich in proteins, vitamins and carbohydrates and provides balanced food. In India, during 2018-19 *Rabi* season, wheat was cultivated in 29.55 mha and production has made a landmark achievement by producing 101.20 mt by registering another record in a average national productivity i.e., 3424 kg ha^{-1}. Uttar Pradesh produces a significant level of wheat with a total record output of 32.21 mt (32%), followed by Punjab (17.78 mt: 18%), Madhya Pradesh (17.35 mt: 17%), Haryana (11.65 mt: 12%), Rajasthan (9.60 mt: 9%) and Bihar (6.02 mt: 6%) (Director's Report; 2018-19). Because of fine alluvial soil deposited by the mighty Ganga and its several big and small tributaries and a close network of canals, supplemented by large number of tube wells have helped U.P. to occupy the top position. More than half of the wheat area lies in the Ganga-Ghagra doab. Next in importance is the Ganga-Yamuna doab. These two doabs account for about 75 per cent wheat of U.P. About 55 districts of Uttar Pradesh produce wheat out of which 43 are the leading producers. Saharanpur, Muzaffanagar, Meerut, Moradabad, Rampur, Budaun, Etawah, Hardoi, Bahraich, Kheri, Gonda, Basti, etc. are the main producing districts. However, wheat production to the east of Varanasi declines due to high rainfall and heavy soils.

"Both grassy and broad-leaved weeds infest wheat. Among grassy weeds, Phalaris minor Retz. and among broad-leaved weeds Rumex dentatus L. are of major concern in irrigated wheat under rice–wheat system in India" [1,2]. "Both P. minor and R. dentatus are highly competitive weeds and can cause drastic yield reduction under heavy infestation. The yield reduction by weeds in wheat may be up to 80% depending upon weed type, density, timing of emergence, wheat density, wheat cultivar and soil and environmental factors" [3]. Choker et al. (2009) observed that "density of P. minor was higher under conventional tillage" [4]. "But, infestation of broad- leaved weed Rumex dentatus and M. denticulata was maximum under zero-tillage condition. Besides reduction in yield and quality of wheat, heavy Rumex spp. populations can cause hindrance in combine harvesting and heavy P. minor populations thus causing crop lodging. Resistance has evolved in P. minor against isoproturon and as a result, it has emerged as a single weed species limiting wheat productivity in the North Western plains of India" [4]. "For sustaining wheat productivity, its control is essential. For the control of isoproturon-resistant P. minor, clodinafop, fenoxaprop and sulfosulfuron have been found effective" [3]. "Clodinafop and fenoxaprop control only grasses, whereas sulfosulfuron controls grasses and some of the broad-leaved weeds" [3,1]. "In areas where the farmers are using graminicides like clodinafop and fenoxaprop, the broad-leaved weed flora particularly Rumex spp. has increased enormously. Under these conditions, broad-spectrum weed control is essential and for that combinations of herbicides are needed. The use of herbicides can be reduced by exploiting allelopathy as an alternate weed management tool for crop production" [5]. "Photosynthesis inhibition, an increase in radicals, a decrease in chlorophyll content, enzymatic activity inhibition, and cell membrane and cell structure disruption are possible mechanisms through which allelochemicals affect the victim plant" [6]. "Allelopathic water extracts in combination with reduced rates of herbicides may provide a synergistic effect for suppressing weeds" [7]. "Several plants are potential candidates to be used as allelochemicals for noxious weed control" [8]. "Although allelochemicals cannot suppress weeds completely, they can be tank-mixed with herbicides to improve weed control and reduce herbicide rates without compromising the level of weed control. Several crops and weeds have shown allelopathic effects against several weed species" [9].

"Allelochemicals usually have a mode of action different from synthetic herbicides, being more easily and rapidly degradable owing to a shorter half-life, with comparatively fewer halogen substituents and no unnatural ring structures. Phytochemicals have low or no toxicity to animals and beneficial insects, possess an array of activity with varying and diverse site of action and have a comparatively high degradation rate" [10]. "Several studies referred to the herbicidal potential of rice cultivars against weeds growth, which involved a wide range of mono and dicot weed species such as *Echinochloa crus-galli, Cyperus difformis* and *Aammania coccinea"* [11]. "Incorporating the residues of rice with high allelopathic activity, minimised rice flatsedge (*Cyperus iria* L.) growth to a similar degree as achieved by the application of propanil and bentazon herbicides" [12]. "Furthermore, another trial showed residues of rice (var. Sarjoo 52) blended into the soil (5–6 cm in depth, 5 tons ha^{-1}) suppressed jungle rice [*Echinochloa colona* (L.) Link], monarch redstem (*Ammania baccifera* L.), *Ammania multiflora* Roxb. and gulf leaf flower (*Phyllanthus fraternus* Webster) (Khan & Vaishya, 1992). Other experiments reported that rice straw suppressed the germination of oat (*Avena sativa*) and wheat (*Triticum aestivum),* Lens sp., *Convolvulus arvensis* L., *Avena ludoviciana* and *Phalaris minor* Retz" [13,14]. By keeping these views, the study entitled "Effect of rice allelopathy, mulch and herbicides on wheat growth" is proposed with a main objective of find out the effect of rice allelochemical, mulch and herbicides on plant height.

2. MATERIALS AND METHODS

2.1 Experimental Site

The experiment was carried out during 2019-20 and 2020-21 Rabi season by using HUW-234 at farm which is situated at Banaras Hindu University, intersected by 25° 18' N latitude and 83° 03' longitudes in the Northern Gangetic alluvial plain on the left river Ganga and at the altitude of 128.93 meter above the mean sea level. Varanasi region falls in the belt of semi-arid to sub-humid climate and receiving mean annual precipitation of 1100 mm and potential evaporation of about 1500 mm with an annual moisture deficit of about 425 mm. The normal period of onset of monsoon in this region usually starts from third week of June and lasts up to the end of September or sometimes up to first week of October.

2.2 Experimental Details

The experiment was laid out in split plot design with three replications. The experiment comprised of three crop establishment methods i.e. C_1 conventional method, C_2 raised bed, C_3 zero-till in main plot, five weed management practices i.e. W_1: Two hand weeding(20 and 40 DAS), W_2: Clodinofop propargyl @ 60g a.i. ha^{-1} + metsulfuron @ 4g a.i. ha^{-1}, W_3: Rice residue as mulch @ 4 t ha^{-1} *fb* clodinofop propargyl + metsulfuron @ 100% of recommended dose (2-4 leaf stage of weed), W_4: Rice residue as mulch @ 4 t ha^{-1} *fb* rice extract (10gL^{-1}) at 2-4 leaf stage of weed, W_5: Clodinofop propargyl @ 75% of recommended dose + rice extract (10gL^{-1}) at 2-4 leaf stage of weed along with control (W_0: Weed check). The allocations of various treatments to different plots were done by randomization using Fisher and Yetes random tables.

2.3 Plant Height

Height of the plants were measured in cm. from soil level up to the base of top most fully expanded leaf until flowering and there after height was measured up to the base of panicle (Neck-node joint). Plant height were recorded at 30, 60, 90 DAS and at harvest.

2.4 Statistical Analysis

The data relating to each character were analyzed statistically by applying the technique of analysis of variance and the significance was tested by "F" test (Gomez and Gomez, 1984).

3. RESULTS AND DISCUSSION

3.1 Crop Establishment Method

Different crop establishment methods affects significantly to the plant height of crop at 30 and 60 DAS, while at 90 DAS and at harvest no significant effect observed. At 30 DAS, plant height was significantly higher with zero-till wheat than raised bed and conventional method of sowing. Also the plant height of wheat was significantly higher with raised bed than conventional method in both years. At 60 DAS, during 2019-20 plant height of wheat crop significantly higher with zero-till than conventional method and at par with raised bed, but in 2020-21 plant height in zero-till significantly higher with both raised bed and conventional method of sowing. Similar result was find by Singh and Yadav [15].

3.2 Weed Management Practices

Different weed management practices like mulch, allelochemical and herbicides significantly effects plant height of the wheat at different growth stages of crop. At 30 DAS, plant height was significantly higher with W_3 (Rice residue as mulch @ 4 t ha^{-1} *fb* clodinofop propargyl + metsulfuron @ 100% of recommended dose) than W_2 (Clodinofop propargyl @ 60g a.i. ha^{-1} + metsulfuron @ 4g a.i. ha^{-1}), W_0 (Weed check), W_4 [Rice residue as mulch @ 4 t ha^{-1} *fb* rice

Table 1. Effect of rice allelopathy, mulch, herbicides and different crop establishment methods on plant height of wheat crop

Treatments	Plant height (cm)							
	30 DAS		60 DAS		90 DAS		At harvest	
	2019-20	2020-21	2019-20	2020-21	2019-20	2020-21	2019-20	2020-21
Crop establishment methods								
C_1: Conventional method	18.90	18.91	45.27	42.50	75.38	77.00	83.67	85.00
C_2: Raised bed	19.77	19.87	48.77	45.00	76.94	77.78	88.78	88.39
C_3: Zero-till	20.72	20.72	48.83	47.27	79.50	80.33	89.44	89.00
LSD (p=0.05)	0.65	0.62	1.94	2.11	6.61	6.74	5.81	5.32
Weed management practices								
W_0: Weed check	19.21	19.11	46.51	44.22	74.22	76.00	82.33	83.67
W_1: Two hand weeding(20 and 40 DAS)	20.19	20.20	47.33	44.33	75.89	77.67	87.55	87.33
W_2: Clodinofop propargyl @ 60g a.i. ha^{-1} + metsulfuron @ 4g a.i. ha^{-1}	19.69	19.68	48.55	45.67	80.00	80.22	88.89	89.11
W_3: Rice residue as mulch @ 4 t ha^{-1} *fb* clodinofop propargyl + metsulfuron @ 100% of recommended dose (2-4 leaf stage of weed)	20.61	20.71	49.22	46.22	80.22	80.89	91.89	90.33
W_4: Rice residue as mulch @ 4 t ha^{-1} *fb* rice extract ($10gL^{-1}$) at 2-4 leaf stage of weed	19.51	19.62	48.00	44.88	77.44	77.78	88.22	88.00
W_5:Clodinofop propargyl @ 75% of recommended dose + rice extract ($10gL^{-1}$) at 2-4 leaf stage of weed	19.49	19.49	46.55	44.33	75.89	77.67	84.89	86.33
LSD (p=0.05)	0.88	0.94	2.92	2.20	4.53	4.45	3.74	3.68

extract ($10gL^{-1}$) at 2-4 leaf stage of weed], W_5 [Clodinofop propargyl @ 75% of recommended dose + rice extract ($10gL^{-1}$) at 2-4 leaf stage of weed], and at par with W_1 [two hand weeding (20 and 40 DAS)] in both years. While at 60DAS increment in plant height with all treatments was at par with each other not shows any significant difference. And at 90 DAS, all treatments show significant increment in plant height than W_0 (weed check) while at par with each other. This trend was observed in both years. During harvesting time, plant height was significantly higher with W_2, W_3, W_4 than W_0 and W_1 in 2019-20 but in 2020-21 W_2, W_3, W_4 show same with W_0.

4. CONCLUSION

According to the result, it concluded that wheat grown on zero-till enhanced the plant height which on latter contribute to the yield per plant and subsequently to the yield per unit area. Similarly, weed managed by keeping residue on field and application of allelochemical (rice extract), herbicides (clodinofop and metsulfuron) increases the plant height, which reduces the losses done by weed infestation.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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