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Effect of Tillage practices and Foliar Spray of Micronutrients on Growth, Yield Components and Yield of Grasspea (*Lathyrus sativus* L.) in Rice-Fallow System

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ABSTRACT

A field experiment was conducted at farmers' field of Rampurhat-II block, Birbhum, West Bengal, India for two consecutive *rabi* seasons (October– March) of 2018–19 and 2019–20 to find out the effect of tillage practices and foliar spray of micronutrients on growth, yield components and yield of grasspea variety Ratan (BioL 212). The experiment was laid out in split plot design replicated thrice having three tillage practices (no tillage *utera*, zero tillage and conventional tillage) in main plots and four levels of foliar spray of micronutrients (no micronutrient spray, foliar spray of Zn @ 0.05% twice at 30 and 45 DAS, foliar spray of B @ 0.1% twice at 30 and 45 DAS and foliar spray of Zn @ 0.05%+foliar spray of B @ 0.1% twice at 30 and 45 DAS) in sub-plots with twelve treatment combinations. Different tillage practices and foliar spray of micronutrients had significant response on various growth parameters, yield attributing characters (no. of pods plant^{-1}, no. of seeds pod^{-1}, 1000 seed weight) and yield (seed and stover) of grasspea. Among tillage practices, highest seed yield and stover yield was recorded under zero tillage (1.03 t ha^{-1} and 1.51 t ha^{-1} respectively whereas foliar spray of Zn @ 0.05% and B @ 0.1% twice at 30 and 45 DAS combinedly registered significantly highest seed yield and stover yield (0.99 t ha^{-1} and 1.69 t ha^{-1}, respectively) among foliar spray of micronutrients.

KEYWORDS: Grasspea, rice-fallow, zero tillage, foliar spray, micronutrients

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1. INTRODUCTION

In India out of 12 m ha of rice fallow, approximately eighty per cent of rice fallow is mainly confined in eastern India, encompassing Assam (1.04 m ha), West Bengal (1.16 m ha), Bihar (0.05 m ha), Jharkhand (0.48 m ha), Chhattisgarh (2.86 m ha), Odisha (2.96 m ha), a few parts of Madhya Pradesh and the states of the North East Hill. With appropriate plant management method, productivity, and profitability from other crops in rice fallow may be enhanced via the use of residual ground humidity (Yadav et al., 2015). Major constraints in cultivation of winter crops in rice–fallows are manyfold and can be classified into biotic, abiotic and social constraints (Anonymous, 2013, Gumma et al., 2016, Chowdhury et al., 2020, Deka et al., 2020). Inclusion of pulses into this monocropping system not only subjugate the problem of nutrient mining but also can turn these tracts into double cropped area, thus increases overall legume production and sustain productivity of the existing production system (Samajdar et al., 2019, Ghosh et al. 2021). Lathryus (*Lathyrus sativus* L.) is one of the popular *rabi*-season pulse crops in West Bengal, occupied an area of 97.1 thousand hectares with a production of 85.9 thousand tonnes during 2019–20 (Anonymous, 2022). After harvest of *kharif* rice farmers get considerably less yield from second crops (0.2– 0.3 t ha^{-1}) grown as paira crop on residual moisture as it faces severe water scarcity at the later stages of growth (Sorokhaibam et al., 2016, Jana et al., 2018, Deka et al., 2021). Indian agriculture is entering into a new era of post green revolution and conservation agriculture is gaining importance due to widespread resource degradation, economic benefit, and sustainability in food production (Nazeer et al., 2012, Grace et al., 2012, Corsi et al., 2012, Behera et al., 2014, Bhan and Behera, 2014, Saha et al., 2020, Yadav et al., 2020).Though the adaptation of conservation tillage is at its initial stage in Indian agricultural scenario, conservation agricultural techniques to minimize loss of soil moisture and progresses seeding though developed for large scale mechanized agriculture need to be adopted for *rabi* pulses also (Sharma et al., 2016, Ramesh et al., 2019, Kumar et al., 2019). Micronutrient deficiencies are frequently associated with growth and productivity of pulses (Gupta et al., 2021). However, in India billions of people suffering from various deficiencies including protein deficiency (Prasad and Shivay, 2019). Foliar spray has been shown to be more successful in improving yields by delaying senescence and converting late flushes of flower into pods thereby balancing source to sink relationship ultimately enhancing grain (Kumar and Padbhushan, 2013, Banerjee et al., 2019). Zinc (Zn) plays various essential roles to plants and carbohydrate metabolism, maintenance of the integrity of cellular membranes, protein synthesis, and regulation of auxin synthesis and pollen formation (Hafeez et al., 2013, Karmakar et al., 2021). Boron (B) increases flower production and retention, pollen tube elongation and germination, and seed and fruit development. Application of boron, either as basal dose or foliar sprays during the growing season can stimulate plant growth or yield (Nagula et al., 2015). In this perspective, there is an enormous opportunity to increase the total cropping area through strategic research in rice–fallows (Pande et al., 2012, Barik, 2021). A few research information is available for these areas on lathyrus in rice-fallow, so the present investigation was undertaken with an objective to evaluate the effects of various crop establishment methods and foliar spray of micronutrients on growth, yield components and yield of grasspea in red and lateritic soil of West Bengal.

2. MATERIALS AND METHODS

A two-year field experiment was carried out on sandy loam soil during *rabi* seasons (October– March) of 2018–19 and 2019–20 at the farmer's field of Rampurhat-II block Birbhum district, West Bengal, India. The field was situated at 24^{0}14'96" N latitude and 87^{0}84'27" E longitude with an average altitude of 143.36 m above mean sea level, having a *p*H of 5.98, electrical conductivity (EC) of 0.23 ds m^{-1} and bulk density of 1.37 g cm^{-3}. The initial level of nutrients viz. N, P, K in soil were 117.35 kg ha^{-1}, 9.93 kg ha^{-1} and 79.14 kg ha^{-1} whereas Zn and B was 0.37 and 0.33 ppm respectively. The investigation involved different combination of tillage practices (main plot) i.e., no tillage *utera*, zero tillage, conventional tillage and foliar spray of micronutrients (sub plot) i.e., no micronutrient spray (water spray), foliar spray of Zn @ 0.05% twice at 30 and 45 DAS, foliar spray of B @ 0.1% twice at 30 and 45 DAS, foliar spray of Zn @ 0.05%+ foliar spray of B @ 0.1% twice at 30 and 45 DAS. In total twelve treatment combinations were laid out with three replications in split plot design. The lathyrus variety BioL 212 was sown 18th October and 20th October during 2018 and 2019, respectively and harvested on 9th March and 10th March during 2019 and 2020, respectively. *Utera* crop were broadcasted seven days before harvesting of rice with a seed rate of 80 kg ha^{-1}. Preparatory tillage to other two crop establishment methods were done as per treatments and seeds were sown @ 60 kg ha^{-1} with a spacing of 30×10 cm^{2}. A recommended dose of 20:40:40 of nitrogen, phosphorus and potassium, as basal dose was applied to the crop through urea, single super phosphate and muriate of potash, respectively. Data were pooled and standard statistical methods were followed for analysing the experimental data (Gomez and Gomez, 1984).

3. RESULTS AND DISCUSSION

3.1. *Growth attributes*

3.1.1. *Effect of tillage practices*

Different tillage practices (viz. no tillage *utera*, zero tillage and conventional tillage) significantly influenced various growth attributes of lathyrus such as plant height, number of branches plant^{-1}, leaf area and dry matter accumulation (Table 1). Among various tillage practices, zero tillage method registered highest plant height (41.2 cm), number of branches plant^{-1} (5.2) and dry matter accumulation (2540.35 kg ha^{-1}) at harvest as well as highest LAI (1.87) at 60 DAS which was higher than conventional tillage and no tillage *utera* system. Superiority in growth attributes of lathyrus under zero tillage system might be attributed to enhanced soil health and microenvironment prevailing under adequate residual moisture. Similar findings were reported by Banjara et al. (2017) and Kumar. (2000).

3.1.2. Effect of foliar spray of micronutrients

Foliar spray of micronutrients (zinc and boron) alone or in combination significantly influenced various growth parameters such as plant height, number of branches plant^{-1}, LAI and dry matter accumulation (Table 1). Foliar spray of Zn @ 0.05% and B @ 0.1% twice at 30 and 45 DAS produced significantly taller plant (40.1 cm), highest number of branches plant^{-1} (6.3) and higher dry matter accumulation (2680.52 kg ha^{-1}) at harvest as well as higher LAI at 60 DAS (1.89) compared with either zinc or boron alone was recorded under treatment foliar spray of Zn @ 0.05%+ foliar spray of B @ 0.1% twice at 30 and 45 DAS (Table 1). Upadhyay and Singh (2016) concluded that foliar application of Zn promoted enhanced branching due to promotion of bud and branch development by the auxins and accelerated the translocation of photo assimilates. Mandal and Sinha (1997) opined that boron increased number of branches owing to important role of boron in plant metabolism and translocation of photosynthates from source to sink. The positive influence of Zn on leaf area mainly attributed to more availability of zinc during subsequent stages of plant growth which had increased photosynthates and 'N' fixation (Nayak et al., 1989). Shekhawat and Shivay (2012) reported that boron application maximizes various growth and yield attributing parameters including seed yield in pulses. Marschner (1995) found that zinc play an important role in activity of aldolase, sucrose synthase and starch synthetase in plant tissues consequently increasing the

Table 1: Effect of tillage practices and micronutrient spray on growth parameters of lathyrus

Treatments	Plant height (cm)(At harvest)	No. of branches plant^{-1} (At harvest)	LAI (At 60 DAS)	Dry Matter Accumulation (kg ha^{-1}) (At harvest)
Tillage practices (T)				
No tillage utera	32.8	3.8	1.73	1964.61
Zero tillage	41.2	5.2	1.87	2540.35
Conventional tillage	37.9	5.0	1.82	2269.70
SEm±	0.46	0.11	0.02	35.62
CD (*p*=0.05)	1.50	0.37	0.05	116.17
Foliar spray of micronutrients (MS)				
No micronutrient spray (water spray)	33.6	2.9	1.67	1875.14
Foliar spray of Zn @ 0.05% twice at 30 and 45 DAS	37.0	4.4	1.80	2159.50
Foliar spray of B @ 0.1% twice at 30 and 45 DAS	38.6	5.0	1.86	2317.73
Foliar spray of Zn @ 0.05%+foliar spray of B @ 0.1% twice at 30 and 45 DAS	40.1	6.3	1.89	2680.52
SEm±	0.66	0.12	0.03	42.04
CD (*p*=0.05)	1.88	0.34	0.07	120.57
Interaction (T×MS)				
SEm±	1.14	0.20	0.04	72.81
CD (*p*=0.05)	NS	NS	NS	NS
Interaction (MS×T)				
SEm±	1.09	0.21	0.04	72.42
CD (*p*=0.05)	NS	NS	NS	NS

NS: Not significant; DAS: Days after sowing dry matter yield in plants. Qiong et al. (2002) reported that B fertilizer significantly enhanced photosynthetic activity of leaves, which consequently resulted in more accumulation of dry matter in peanut (*Arachis hypogea* L.).

3.2. Yield attributes and yield

3.2.1. Effect of tillage practices

Pods plant^{-1} along with other yield attributing characters varied significantly due to different tillage practices (Table 2). Amongst tillage practices, zero tillage significantly recorded higher number of pods plant^{-1} (29.1) and seeds pod^{-1} (3.9) resulting in more seed yield of 1.03 t ha^{-1}. Similar to seed yield highest stover yield (1.51 t ha^{-1}) was recorded under zero tillage. Comparatively better performance of crop plants under zero tillage and conventional tillage could be attributed to better establishment as well as better utilization of available soil moisture. Abid et al. (2018) reported superior seed and stover yield of green gram in minimum tillage.

3.2.2. Effect of foliar spray of micronutrients

Foliar application of Zn @ 0.05%+B @ 0.1% twice at 30 and 45 DAS produced significantly higher number of pods plant^{-1} (10.9) and seeds pod^{-1} (4.4) which ultimately increased seed yield (0.99 t ha^{-1}) as well as stover yield (1.69 t ha^{-1}) (Table 2). The enhanced yield attributing characters with the spray of micronutrients might be due to triggered photosynthetic ability which in turn positively favored dry matter accumulation and also efficient partitioning of photosynthates towards sink (Mondal et al., 2011). Significantly higher seed yield (0.99 t ha^{-1}) and stover yield (1.69 t ha^{-1}) were recorded in the same treatment with combined use of zinc and boron as foliar spray. Findings of Valenciano et al. (2010) also endorsed the results recorded in the present investigation.

3.3. Nutrient uptake

3.3.1. Effect of tillage practices

Nutrient uptake by lathyrus seed were significantly influenced due to different tillage practices (Table 3). Amongst various crop establishment methods, zero tillage exhibited significantly higher Nitrogen (21.75 kg ha^{-1}), phosphorus (9.59 kg ha^{-1}), potassium (31.99 kg ha^{-1}), zinc (54.84 g ha^{-1}) and boron (70.97 g ha^{-1}) uptake in comparison

Table 2: Effect of tillage practices and micronutrient spray on yield attributing characteristics and yield of lathyrus

Treatments	No. of pods plant^{-1}	No. of seeds pod^{-1}	1000 seed weight (g)	Seed yield (t ha^{-1})	Stover yield (t ha^{-1})
Tillage practices (T)					
No tillage utera	7.3	2.5	61.71	0.78	1.19
Zero tillage	8.8	3.9	64.39	1.03	1.51
Conventional tillage	8.3	3.3	62.92	0.92	1.34
SEm±	0.21	0.07	2.03	0.01	0.02
CD (p=0.05)	0.68	0.24	NS	0.05	0.07
Foliar spray of micronutrients (MS)					
No micronutrient spray (water spray)	5.9	1.9	63.77	0.83	1.05
Foliar spray of Zn @ 0.05% twice at 30 and 45 DAS	7.2	3.1	61.08	0.90	1.26
Foliar spray of B @ 0.1% twice at 30 and 45 DAS	8.5	3.5	61.88	0.92	1.40
Foliar spray of Zn @ 0.05%+foliar spray of B @ 0.1% twice at 30 and 45 DAS	10.9	4.4	65.29	0.99	1.69
SEm±	0.36	0.14	1.67	0.01	0.03
CD (p=0.05)	1.03	0.40	NS	0.04	0.09
Interaction (T×MS)					
SEm±	0.62	0.24	2.89	0.02	0.06
CD (p=0.05)	NS	NS	NS	NS	NS
Interaction (MS×T)					
SEm±	0.58	0.22	3.22	0.02	0.05
CD (p=0.05)	NS	NS	NS	NS	NS

NS: Not significant; DAS: Days after sowing

Table 3: Effect of tillage practices and micronutrient spray on nutrient uptake by lathyrus seeds

Treatments	N uptake (kg ha^{-1})	P uptake (kg ha^{-1})	K uptake (kg ha^{-1})	Zinc uptake (g ha^{-1})	Boron uptake (g ha^{-1})
Tillage practices (T)					
No tillage utera	14.21	6.10	23.15	35.78	49.68
Zero tillage	21.75	9.59	31.99	54.84	70.97
Conventional tillage	17.80	7.83	27.97	45.92	61.02
SEm±	1.03	0.48	0.97	2.11	2.54
CD (p=0.05)	3.35	1.56	3.17	6.87	8.28
Foliar spray of micronutrients (MS)					
No micronutrient spray (water spray)	13.98	6.27	20.98	30.60	43.25
Foliar spray of Zn @ 0.05% twice at 30 and 45 DAS	17.39	7.34	26.70	53.02	56.80
Foliar spray of B @ 0.1% twice at 30 and 45 DAS	18.72	7.09	28.03	37.24	66.68
Foliar spray of Zn @ 0.05%+foliar spray of B @ 0.1% twice at 30 and 45 DAS	21.59	10.66	35.11	61.19	78.65
SEm±	0.77	0.49	0.98	2.12	2.88
CD (p=0.05)	2.21	1.40	2.81	6.08	8.25
Interaction (T×MS)					
SEm±	1.34	0.85	1.70	3.67	4.98
CD (p=0.05)	NS	NS	NS	NS	NS
Interaction (MS×T)					
SEm±	1.55	0.88	1.76	3.81	4.95
CD (p=0.05)	NS	NS	NS	NS	NS

NS: Not significant; DAS: Days after sowing

to other two crop establishment methods. Comparatively higher nutrient uptake under zero tillage treatment might be attributed to superior seed yield under zero tillage in the present investigation as evidenced from the findings of Ghosh et al. (2022), Sharma (2002), Mishra et al. (2013), Wozniak and Gaweda (2019) and Nadeem et al. (2019).

3.3.2. Effect of foliar spray of micronutrients

Foliar application of Zn @ 0.05%+B @ 0.1% twice at 30 and 45 DAS recorded significantly higher nitrogen (21.59 kg ha^{-1}), phosphorus (10.66 kg ha^{-1}), potassium (35.11 kg ha^{-1}), zinc (61.19 g ha^{-1}) and boron (78.65 g ha^{-1}) uptake (Table 3) when compared with sole application of either Zn or B or no micronutrient application. The enhanced nutrient uptake with the spray of micronutrients both zinc and boron might be due to increased yield attributing characters and ultimately seed yield. Similar findings were reported by Seema et al. (2014), Thiyagarajan et al. (2003), Mengel and Kirkby (1978), Umesh et al. (2013), and Shamsuddoha et al. (2011).

3.4. Effect of interaction

Different tillage practices and foliar spray of micronutrients did not bring any significant difference between them with respect to growth attributes, yield attributes, yield and nutrient uptake of lathyrus.

4. CONCLUSION

Among different tillage practices, zero tillage was most efficient for increasing growth parameters, yield attributing characters and yield of lathyrus. Combined use of zinc @ 0.05%+boron @ 0.1% as foliar spray registered significantly higher growth attributes, yield attributes and yield of lathyrus than individual application of either zinc or boron twice at 30 and 45 DAS in rice fallow of red and lateritic soil of West Bengal.

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