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Research Article

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Effect of Planting Methods and Management Practices on Banded Leaf and Sheath Blight and Bacterial Stalk Rot of Maize

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ABSTRACT

Banded leaf and sheath blight caused by Rhizoctonia solani and Bacterial stalk rot caused by Dickeya zeae (Erwinia chrysanthemi pv. zeae) are highly destructive disease of maize crop worldwide including India. These are serious constraint and limit maize production considerably in various hot and humid tropical maize growing regions of the world. It may cause premature death, stalk breakage and ear rot. It reduces the grain yield and grain quality for human consumption. Loss in grain yield ranges from moderate to high depending upon weather conditions. During the recent year stalk rots has emerged as one of most important disease in kharif sown maize crop in India. Both the diseases have been described from various parts of the world. These pathogens have wide host range which makes it difficult to manage. Growing conditions creating warm and wet conditions are most favorable for the development of the disease. A field experiment was carried out by integrating planting methods like- paired row planting, ridge planting and flat planting along with different management approaches like- chemical, biological and integrated for the management of Banded leaf and sheath blight and Bacterial stalk rot of maize under tarai condition of Uttrakhand. Results of present study indicated that ridge planting and paired row planting methods and in management practices, chemical control and integrated management methods were found equally good in minimizing the incidence and severity of Banded leaf and sheath blight and Bacterial stalk rot. However, ridge planting and chemical control measure provided significantly higher yield as compared to paired row planting and integrated management practices. Biological control was found least effective.

Keywords: *Bacterial stalk rot, Planting methods, Chemical control, Biological control, Integrated management.*

INTRODUCTION

Maize is an important food crop which is affected by several diseases. These diseases are classified mainly on the basis of plant part affected. Among them stalk rots are considered as most serious as it affects flow of nutrients from root to upper plants parts and often whole plant either get dry or broken from the base resulting in huge yield losses.

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Banded leaf and sheath blight (BLSB), a soil-borne disease caused by *Rhizoctonia solani f. sp. sasakii* has been reported from several maize growing countries and is more prevalent in humid weather with temperature of around 28 ^{0}C can cause complete wipeout of the crop (Tang et al., 2004). The pathogen spreads from the basal sheath to the developing ear under favorable environmental conditions. The developing ear is completely damaged and dries up prematurely with caking of husk leaves (Kumar & Singh, 2004). BLSB poses challenge to maize growers as it is not adequately controlled either through use of fungicides or crop rotation. A combination of management practices is required for BLSB control.

Bacterial stalk rot (BSR) is another important disease of the maize, which topple down maize plant under severe conditions and emit foul odor. This disease resulted in severe grain yield losses which can range from 21 to 98 per cents (Thind & Payak, 1978). In India bacterial stalk rot was reported for the first time by Prasad (1930). Burkholder et al. (1953) reported that the *Erwinia chrysanthemi*a phytopathogenic bacterium induces soft rot and wilting. The pathogen has been re classified as *Dickeya zeae*. During the recent year bacterial stalk rot has emerged as one of most important disease in *kharif* sown maize crop in India (Kumar et. al., 2015 a). The pathogen spreads from plant to plant and field to field through rainwater and its runoff. The infestation of the bacterial soft rot have been reported from various parts of the world (Hingorani et al., 1959; Pauer, 1964; Prasad, 1930; Sabet, 1954; Volcani, 1961; Zachos et al., 1963; Martinez-Cisneros et al., 2014). This bacterium has a wide host range which makes it difficult to manage (Bradbury, 1986; Goto, 1979).

Pandey (1992) reported that integration of management practices such as seed coating with antagonist or seed treatment by chemicals, foliar sprays of fungicides were effective in reducing disease severity. *Trichoderma species* were highly antagonistic to *Rhizoctonia solani* (Dumitras, 1984; Goswami, 2008, Sharma, 2012). Treatments with bio-agents *Trichoderma viride, Trichoderma harzianum* resulted low disease severity and increased grain yield. Singh (2000) reported that seed treatment with *Trichoderma harzianum* gave maximum increase in root length of maize seedlings while the foliar spray of *Gliocladium virens* reduced the disease and increased yield. *Trichoderma viride* was found more effective than *Pseudomonas fluorescens* (Goswami, 2008, Sharma, 2012). Combination of *T. harzianum* + *P. fluorescens* was more effective against Banded Leaf and Sheath Blight (Mehra, 2008; Sharma, 2012).

There are many reports that support combinations of propiconazole 25 % EC with biological control were very effective in reducing the severity of banded leaf and sheath blight severity and also increased yield (Singh, 2000; Mishra, 1998, Sharma, 1996, Sharma, 2012). Rijal (2003) reported that foliar sprays of propiconazole @ 0.1 % and bio-agents @ 1% reduced the incidence of BLSB but propiconazole was found superior over bio-agents.

Bacterial stalk rot can be suppressed by use of organic manure amendment which stimulates the population of beneficial microflora. Avoid flooding and excessive irrigation minimizes incidence and severity of stalk rots. Ridge sowing method was found useful in managing this disease. Kumar et al. (2015b) found minimum disease incidence and severity in raised bed planting as compared to flat sown method during survey of farmer's field condition of Punjab. *Trichoderma harizianum* was found effective in minimizing the bacterial stalk rot and enhancing the yield but proved less effective as compared to chemical control and integrated management practices. Kumar et al. (2016) reported efficacy of *Pseudomonas fluorescence* against *D. zeae* under *in vitro* condition only not under field conditions.

Cultivation practices favoring high humidity and moderate temperature conditions may influences the development of banded leaf and sheath blight and bacterial stalk rot.

Several compounds have been reported in the literature for control of these diseases but due to environmental hazards and high cost limit the use of these chemicals. Keeping in view the considerable loose caused by these diseases in the region an integrated approach involving various sowing methods and management practices were evaluated for the management of banded leaf and sheath blight and bacterial stalk rot of maize under *tarai* conditions of Uttarakhand.

MATERIALS AND METHODS

Field experiment was conducted during *kharif* 2017 and 2018 in Maize Pathology block at Norman E. Borlaug Crop Research Centre, G.B. Pant University of Agriculture and Technology, Pantnagar, Udham Singh Nagar, Uttarakhand. It has sub tropical climate with hot and humid summer and cold winters. Field was ploughed 20-25 cm deep with soil turning plough, two to three cross harrowing and planking were done to make field smooth and well leveled. One pre planting irrigation was given to ensure good moisture. NPK and Zn fertilizers were applied @ 100, 60, 40 and 25 kg/ha, respectively. Plots were hand weeded with the help of hoe regularly. Field experiments were conducted using moderately susceptible variety Pant Sankul Makka 3. Plot size was 3.0 meter x 4.05 meter with three replication of each treatment. Trial was laid out in split plot design with three types of sowing methods *viz*. Paired row planting (PRP), ridge planting (RP) and flat planting (FP) as in main plot and four sub plots *viz.* Chemical control (CC), Biological control (BC), Integrated management (IM) and Untreated control (UC). In Paired row planting (PRP) row to row spacing was 45 cm and plant to plant 20 cm with continuous sowing of two rows with one skipped row, in Ridge planting (RP) and Flat planting (FP) spacing was 67.5 x 20 cm. Under sub plots, in Chemical control (CM) seed was treated with Carbendazim + Thiram (1:2) @ 3 g/kg seed followed by two prophylactic spray of Propiconazole 25 % EC @ 500 ml/ha. In Biological control (BC) seed was treated with *Trichoderma harzianum* (Pant bioagent-1) @ 10 g/ kg seed followed by two spray of *Trichoderma harzianum* (Pant bioagent-1) @ 1.0%, in Integrated management (IM) seed was treated with *Trichoderma harzianum* (Pant bioagent-1) @ 10 g/kg seed followed by first spray of Propiconazole 25 % EC @ 500 ml/ha followed by second spray of *Trichoderma harzianum* (Pant bioagent-1) @ 1%. In all treatments two sprays were applied at 30 and 45 days after sowing (DAS). In Untreated control (UC) seeds, were sown without treatment and water was used in both sprays.

Observations on disease incidence and severity were recorded at 40, 55, 70 and 85 days after sowing. For disease severity rating was done using 1-9 scale (Hooda et al., 2018) and Per cent diseases Index (PDI) was calculate using formula given by Wheeler (1969).

$$\text{PDI} = \frac{\text{Sum of all disese ratings}}{\text{Total no. of observation x Highest disease ratting scale}} x100$$

Percent incidence was calculated using following formula.

$$\text{Disease incidence} = \frac{\text{No. of disease plant}}{\text{total no of plant observed}} x100$$

Grain yield (kg/plot) was calculated and expressed as grain yield in (q/ha). Per cent Increase in Yield (PIY) in yield was calculated using formula given by **Pradhan** (1969).

$$\text{PIY} = \frac{\text{Yield in treatment} - \text{Yield in control}}{\text{Yield in control}} x100$$

Data was statistically analyzed using online programme “OPSTAT” a Statistical Software Package for Agricultural Research Workers developed by Sheoran et al. (1998).

Rating scale for Banded leaf & sheath blight (BL & SB)

Scale	Degree of infection (% Diseased area in Plant)
1.0	Disease on one leaf sheath only; few small, non-coalescent lesions present (≤10%).
2.0	Disease on two sheaths; lesions large and coalescent (10.1-20%).
3.0	Disease up to four sheaths; lesions many and always coalescent (20.1-30%).
4.0	As in disease rating symptoms of 3.0, + rind discolored with small lesions (30.1-40%).
5.0	Disease on all sheaths except two internodes blow the ear (40.1-50%).
6.0	Disease up to one internode below ear shoot, rind discoloration on many internodes with large depressed lesions (50.1-60%).
7.0	Disease up to the internodes bearing the ear shoot but shank not affected (60.1-70%).
8.0	Disease on the ear; husk leaves show bleaching, bands and cracking among themselves as also silk fibers; abundant fungal growth between and on kernels; kernels formation normal except being lusterless; ear size less than normal; some plants prematurely dead (70.1-80%).
9.0	In addition to disease rating symptoms of 8.0, shrinkage of stalk; reduced ear dimension; wet rot and disorganization of ear; kernel formation absent or rudimentary; prematurely dead plants common; abundant sclerotia production on husk leaves, kernels ear tips and silk fibers (>80%).

RESULT AND DISCUSSION

Effect of sowing methods and disease management measures on incidence of banded leaf and sheath blight.

Disease incidence at different interval showed that different sowing methods taken as main plot and different disease management practices as sub plots differed significantly but their interaction was found in significant (Table 1).

Pooled disease incidence recorded 40 days after sowing (DAS) varied from 11.70 to 13.76 percent. Minimum disease incidence (11.70 %) was recorded in ridge planting followed by 12.44 percent in paired row planting while highest (13.76 %) in flat planting (normal method followed by farmers considered as control to calculate percent disease control). Similar trend was noticed 55 and 70 DAS. Disease incidence recorded 85 DAS ranged from 37.39 to 44.12 percent being minimum (37.39 %) in ridge planting and maximum (44.12 %) in flat planting. At terminal observation (85 DAS) highest percent disease control (15.25 %) was recorded in ridge planting and 8.84 percent in paired row planting (Table 1).

In disease management practices pooled disease incidence recorded at 40 DAS varied from 9.02 -17.33 percent. Similar trends were observed at subsequent observation. At terminal observation (85 DAS) disease incidence ranged from 29.00 to 53.12 percent. It was minimum (29.12 %) in chemical control and maximum (53.12 %) in untreated control. Next best treatment was integrated management where 35.80 percent disease incidence was recorded followed by 44.39 percent in biological control. Percent disease control was 45.41, 32.61 and 16.43 percent in chemical control, integrated management and bio-control, respectively (Table 1).

Effect of sowing methods and disease management measures on severity of banded leaf and sheath blight.

Disease severity calculated in terms of Percent Disease Index (PDI) at different interval showed that different sowing methods taken as main plot and different disease management practices as sub plots were found significantly different but their interactions were insignificant (Table 2).

Pooled PDI recorded 40 days after sowing (DAS) varied from 12.78 to 16.67. Minimum PDI (12.78) was recorded in ridge planting followed by 13.98 in paired row planting while highest in flat planting (normal method followed by farmers considered as control to calculate percent disease control). Similar trend was noticed 55 and 70 DAS. PDI recorded 85 DAS ranged from 23.34 to 30.74 being minimum (23.34) in ridge planting and maximum (30.74) in flat planting. At terminal observation (85 DAS) highest percent disease control (24.07 %) was recorded in ridge planting and 17.18 % in paired row planting (Table 2).

In disease management practices pooled PDI recorded at 40 DAS varied from 12.10 -18.89. Similar trends were observed at each observation. At terminal observation (85DAS) PDI ranged from 21.73 to 33.46 being minimum (21.73) in chemical control and maximum (33.46) in untreated control. Next best treatment was integrated management where 23.70 PDI was recorded followed by 27.16 in biological control. Percent disease control was 35.06, 29.17 and 18.83 percent in chemical control, integrated management and bio-control, respectively (Table2).

In sowing methods raised bed and paired row planting methods was found to be at par in minimizing the incidence and severity of Banded leaf and sheath blight (BLSB). Hooda et. al. (2015) have reported that selection of well-drained field and planting on raised beds are important cultural aspects to avoid contact of excess water with seeds and faster growth of maize seedlings and minimizing the BLSB. Under disease management practices all treatments were found effective as compared to untreated control in minimizing the BLSB incidence. However, chemical control proved to be superior followed by integrated management. But in reducing the severity of BLSB chemical control and integrated management was at par. Biological control proved to be least effective in controlling disease incidence as well as severity. Integration of seed treatment with antagonist or chemicals with foliar sprays of fungicides were effective in reducing banded leaf and sheath blight severity and increasing yield (Pandey,1992; Singh, 2000).

Effect of sowing methods and disease management measures on incidence of bacterial stalk rot.

Incidence of bacterial stalk rot recorded at 55 days. Different sowing methods taken as main plot and different disease management practices as sub plots were significantly different but their interaction was found statistically insignificant (Table 3).

Disease incidence recorded 55 days after sowing (DAS) varied from 4.92 to 7.26 percent. Minimum Disease incidence (3.32 %) was recorded in ridge planting followed by 5.87 percent in paired row planting while highest (7.26 %) in flat planting (normal method followed by farmers considered as control to calculate percent disease control). Similar trend was noticed 70 and 85 DAS. Disease incidence recorded 85 DAS ranged from 10.88 to 15.94 percent being minimum (10.88 %) in ridge planting and maximum (15.94 %) in flat planting. At terminal observation (85 DAS) highest percent disease control (31.74 %) was recorded in ridge planting and 19.13 percent in paired row planting (Table 3).

In disease management practices pooled Disease incidence recorded at 55 DAS varied from 4.52 -8.41 percent. Similar trends were observed at each observation. At terminal observation (85DAS) Disease incidence ranged from 10.21 to 16.71 percent being minimum (10.21 %) in chemical control and maximum (16.71 %) in untreated control. Next best treatment was integrated management where 12.19 % disease incidence was recorded followed by 13.82 percent in biological control. Percent disease control was 38.90, 27.05 and 17.30 percent in chemical control, integrated management and bio-control, respectively (Table 3).

In planting methods raised bed was found best in controlling the incidence of bacterial stalk rot (BSR) followed by paired row while flat planting found to be least effective. Similarly under disease management practices all treatments differed significantly with each other. Maximum control was observed in chemical control followed by integrated management. Minimum control of BSR was found in biological control. Ridge sowing method was found useful in managing Bacterial stalk rot (Kumar et al., 2015b). Kumar et al. (2016) reported efficacy of *Trichoderma harizianum* in minimizing the bacterial stalk rot and enhancing the yield but found less effective as compared to chemical control and integrated management practices.

Effect of sowing methods and disease management measures on yield of maize.

Grain yield in different sowing methods as well as under different disease management practices differed significantly but their interaction was found insignificant. Pooled yield under different sowing methods ranged from 30.12-36.57 q/ha. Highest yield (36.57 q/ha) was recorded in ridge planting followed by paired row planting (32.79 q/ha) while lowest (30.12 q/ha) in flat planting. Ridge planting provided 21.41 percent increase in yield however it was 8.86 percent in paired row planting method (Table 4).

Among different disease management practices highest pooled yield (37.45 q/ha) was recorded in chemical control followed by 34.04 q/ha in integrated management and 32.27 q/ha in biological control while lowest yield (28.87 q/ha) was recorded in untreated control. Percent increase in yield was 29.72 percent in chemical control followed by 17.91 percent in integrated management while lowest (11.78%) in biological control (Table 4). Enhancement in yield along with disease management due to various treatments has already been reported in maize (Kumar et al., 2016; Singh, 2000).

Table 1: Effect of sowing methods and disease management practices on incidence of banded leaf and sheath blight

Sowing methods/ Management practices		40 DAS			55 DAS			70 DAS			85 DAS			
		2017	2018	Pooled	2017	2018	Pooled	2017	2018	Pooled	2017	2018	Pooled	Per cent diseases control
PRP	CC	9.16	8.99	9.07	13.43	13.18	13.30	21.36	20.96	21.16	29.30	28.75	29.02	44.08
	BC	13.04	13.34	13.19	19.24	19.70	19.47	30.43	31.17	30.80	43.46	44.52	43.99	15.24
	IM	10.89	9.93	10.41	16.66	15.52	16.09	26.90	24.22	25.57	37.79	34.15	35.97	30.69
	UC	17.33	16.87	17.10	25.28	24.64	24.96	37.25	36.31	36.78	52.57	51.23	51.90	0.00
RP	CC	8.30	8.48	8.39	12.17	12.42	12.29	18.81	19.21	19.01	26.58	27.11	26.84	43.59
	BC	12.81	12.88	12.84	18.30	18.41	18.35	28.66	28.83	28.75	41.47	41.72	41.59	12.59
	IM	10.31	9.65	9.98	15.77	15.07	15.42	24.24	22.89	23.56	34.55	32.54	33.54	29.51
	UC	15.98	15.15	15.57	23.08	21.81	22.45	34.91	32.72	33.81	49.11	46.06	47.58	0.00
FP	CC	9.65	9.51	9.59	13.88	13.67	13.77	22.33	21.97	22.15	31.41	30.86	31.13	48.01
	BC	14.93	15.05	14.99	21.43	21.59	21.51	33.11	33.38	33.24	47.40	47.76	47.58	20.54
	IM	11.46	10.84	11.14	17.19	16.57	16.88	27.37	26.12	26.75	38.83	36.96	37.89	36.72
	UC	19.38	19.28	19.33	28.42	27.97	28.20	42.62	42.27	42.45	60.06	59.69	59.88	0.00
Sowing method														
PRP		12.60	12.28	12.44	18.65	18.26	18.46	28.99	28.17	28.58	40.78	39.66	40.22	8.84
RP		11.85	11.54	11.70	17.33	16.93	17.13	26.66	25.91	26.28	37.93	36.86	37.39	15.25
FP		13.86	13.67	13.76	20.23	19.95	20.09	31.36	30.94	31.15	44.42	43.82	44.12	0.00
SE(m)		0.37	0.19	0.27	0.49	0.27	0.38	0.85	0.34	0.59	1.21	0.53	0.86	-
CD @ 5%		1.48	0.78	1.10	1.99	1.11	1.51	3.41	1.35	2.36	4.88	2.15	3.47	-
Disease Management Practices														
CC		9.04	8.99	9.02	13.16	13.09	13.12	20.83	20.71	20.77	29.10	28.91	29.00	45.41
BC		13.59	13.76	13.67	19.66	19.90	19.78	30.73	31.13	30.93	44.11	44.67	44.39	16.43
IM		10.88	10.14	10.51	16.54	15.72	16.13	26.17	24.41	25.29	37.06	34.55	35.80	32.61
UC		17.56	17.10	17.33	25.60	24.81	25.20	38.26	37.10	37.68	53.91	52.33	53.12	0.00
SE(m)		0.47	0.36	0.39	0.61	0.54	0.55	0.89	0.83	0.80	1.38	1.16	1.19	-
CD @ 5%		1.42	1.07	1.18	1.84	1.60	1.64	2.67	2.48	2.39	4.14	3.47	3.57	-

* DAS days after sowing, PRP paired row planting, RP ridge planning, FP Flat planting, CC Chemical control, BC Bio-control, IM Integrated management and UC Untreated control.

Table 2: Effect of sowing methods and disease management practices on severity (PDI) of banded leaf and sheath blight

Sowing methods / Management practices		40 DAS			55 DAS			70 DAS			85 DAS			
		2017	2018	Pooled	2017	2018	Pooled	2017	2018	Pooled	2017	2018	Pooled	Per cent diseases control
PRP	CC	11.85	11.11	11.48	13.33	11.85	12.59	17.78	15.56	16.67	20.00	20.74	20.37	36.78
	BC	14.81	12.59	13.70	17.04	14.81	15.92	21.48	19.26	20.37	25.18	27.41	26.30	18.37
	IM	13.33	11.85	12.59	14.82	13.33	14.07	19.26	17.04	18.15	22.22	23.70	22.96	28.74
	UC	19.26	17.04	18.15	22.22	20.00	21.11	26.67	24.44	25.56	31.11	33.33	32.22	0.00
RP	CC	10.37	10.37	10.37	11.85	11.11	11.48	15.56	13.33	14.44	17.78	17.78	17.78	43.52
	BC	13.33	11.85	12.59	15.56	13.33	14.44	20.00	17.78	18.89	23.70	25.19	24.45	22.33
	IM	11.11	10.37	10.74	13.33	11.85	12.59	17.04	14.82	15.93	19.26	20.00	19.63	37.64
	UC	18.52	16.30	17.41	20.74	19.26	20.00	25.93	23.70	24.82	30.37	32.59	31.48	0.00
FP	CC	15.56	13.33	14.44	17.78	15.56	16.67	22.22	20.00	21.11	25.93	28.15	27.04	26.26
	BC	17.78	15.56	16.67	20.00	17.78	18.89	25.18	22.96	24.07	29.63	31.85	30.74	16.17
	IM	15.56	13.33	14.44	18.52	16.30	17.41	22.96	20.74	21.85	27.41	29.63	28.52	22.23
	UC	22.22	20.00	21.11	25.18	22.96	24.07	30.37	28.15	29.26	35.56	37.78	36.67	0.00
Sowing method														
PRP		14.81	13.15	13.98	16.85	15.00	15.92	21.30	19.07	20.19	24.63	26.30	25.46	17.18
RP		13.33	12.22	12.78	15.37	13.89	14.63	19.63	17.41	18.52	22.78	23.89	23.34	24.07
FP		17.78	15.56	16.67	20.37	18.15	19.26	25.18	22.96	24.07	29.63	31.85	30.74	0.00
SE(m)		0.55	0.47	0.50	0.73	0.66	0.69	0.85	0.85	0.85	0.74	0.87	0.80	-
CD @ 5%		2.22	1.88	2.01	2.92	2.68	2.79	3.42	3.42	3.43	2.97	3.52	3.24	-
Disease Management Practices														
CC		12.59	11.60	12.10	14.32	12.84	13.58	18.52	16.30	17.41	21.24	22.22	21.73	35.06
BC		15.31	13.33	14.32	17.53	15.31	16.42	22.22	20.00	21.11	26.17	28.15	27.16	18.83
IM		13.33	11.85	12.59	15.56	13.83	14.69	19.75	17.53	18.64	22.96	24.44	23.70	29.17
UC		20.00	17.78	18.89	22.71	20.74	21.73	27.65	25.43	26.54	32.35	34.57	33.46	0.00
SE(m)		0.75	0.69	0.71	0.89	0.79	0.83	0.98	0.98	0.98	1.23	1.32	1.27	-
CD @ 5%		2.26	2.06	2.14	2.67	2.36	2.48	2.94	2.94	2.94	3.67	3.96	3.79	-

* DAS days after sowing, PRP paired row planting, RP ridge planning, FP Flat planting, CC Chemical control, BC Bio-control, IM Integrated management and UC Untreated control.

Table 3: Effect of sowing methods and disease management practices on incidence of bacterial stalk rot

Sowing methods/Management practices		55 DAS			70 DAS			85 DAS			
		2017	2018	Pooled	2017	2018	Pooled	2017	2018	Pooled	Per cent diseases control
PRP	CC	4.25	4.18	4.21	7.27	7.16	7.21	9.10	10.13	9.62	42.53
	BC	5.59	5.74	5.67	9.32	10.81	10.07	12.43	14.63	13.54	19.12
	IM	5.12	4.95	5.03	8.96	8.68	8.82	10.89	12.41	11.65	30.41
	UC	8.66	8.44	8.55	12.66	13.61	13.14	15.96	17.51	16.74	0.00
RP	CC	3.32	3.40	3.36	5.53	5.63	5.58	7.19	7.87	7.53	46.56
	BC	4.87	4.90	4.89	8.53	8.59	8.56	10.36	12.27	11.32	19.66
	IM	4.24	4.22	4.23	7.89	7.84	7.86	9.70	11.46	10.58	24.91
	UC	7.10	7.27	7.19	10.65	11.53	11.09	13.01	15.17	14.09	0.00
FP	CC	6.06	5.95	6.00	9.68	10.68	10.18	12.72	14.26	13.49	30.10
	BC	7.15	7.18	7.16	11.70	13.06	12.38	15.60	17.64	16.62	13.89
	IM	6.37	6.36	6.37	10.20	11.46	10.82	13.39	15.27	14.33	25.75
	UC	9.68	9.32	9.51	14.82	14.91	14.87	18.70	19.90	19.30	0.00
Sowing method											
PRP		5.90	5.83	5.87	9.56	10.07	9.81	12.10	13.67	12.89	19.13
RP		4.88	4.95	4.92	8.15	8.40	8.27	10.07	11.69	10.88	31.74
FP		7.32	7.20	7.26	11.60	12.53	12.06	15.10	16.77	15.94	0.00
SE(m)		0.18	0.15	0.16	0.11	0.28	0.17	0.30	0.20	0.24	-
CD @ 5%		0.74	0.62	0.65	0.44	1.14	0.67	1.21	0.81	0.96	-
Disease Management Practices											
CC		4.54	4.51	4.52	7.49	7.82	7.66	9.67	10.75	10.21	38.90
BC		5.87	5.94	5.91	9.85	10.82	10.34	12.80	14.85	13.82	17.30
IM		5.24	5.18	5.21	9.02	9.33	9.17	11.33	13.05	12.19	27.05
UC		8.48	8.34	8.41	12.71	13.35	13.03	15.89	17.53	16.71	0.00
SE(m)		0.32	0.29	0.30	0.41	0.43	0.40	0.50	0.54	0.51	-
CD @ 5%		0.94	0.88	0.90	1.22	1.28	1.19	1.51	1.63	1.53	-

* DAS days after sowing, PRP paired row planting, RP ridge planning, FP Flat planting, CC Chemical control, BC Bio-control, IM Integrated management and UC Untreated control.

Table 4: Effect of sowing methods and disease management practices on yield of maize

Sowing methods / Management practices		Grain Yield (q/ha)			Per cent increase in yield		
		2017	2018	Pooled	2017	2018	Pooled
PRP	CC	37.31	37.15	37.24	28.08	35.44	31.64
	BC	32.59	30.98	31.78	11.88	12.94	12.34
	IM	34.22	33.45	33.84	17.47	21.95	19.62
	UC	29.13	27.43	28.29	0.00	0.00	0.00
RP	CC	40.58	40.58	40.58	23.49	25.25	24.36
	BC	35.95	35.33	35.64	9.40	9.04	9.22
	IM	38.57	36.26	37.42	17.38	11.91	14.68
	UC	32.86	32.40	32.63	0.00	0.00	0.00
FP	CC	35.38	33.69	34.54	31.92	37.06	34.40
	BC	30.45	28.29	29.37	13.53	15.09	14.28
	IM	32.33	29.36	30.85	20.54	19.45	20.04
	UC	26.82	24.58	25.70	0.00	0.00	0.00
Planting Methods							
PRP		33.31	32.25	32.79	6.59	11.28	8.86
RP		36.99	36.14	36.57	18.37	24.71	21.41
FP		31.25	28.98	30.12	0.00	0.00	0.00
SE(m)		0.24	0.40	0.28	-	-	-
CD @ 5%		0.98	1.59	1.13	-	-	-
Disease Management Practices							
CC		37.76	37.14	37.45	27.57	31.98	29.72
BC		33.00	31.53	32.27	11.49	12.05	11.78
IM		35.04	33.03	34.04	18.38	17.38	17.91
UC		29.60	28.14	28.87	0.00	0.00	0.00
SE(m)		0.29	0.30	0.22	-	-	-
CD @ 5%		0.86	0.91	0.65	-	-	-

* PRP paired row planting, RP ridge planning, FP Flat planting, CC Chemical control, BC Bio-control, IM Integrated management and UC Untreated control.

CONCLUSION

Results of present study indicated that in planting methods ridge planting and paired row planting and under diseased management practice chemical control and integrated management were found equally good in minimizing the incidence as well as severity of Bended Leaf and Sheath Blight and Bacterial Stalk Rot of maize. However, ridge planting method and chemical control measures provided significantly higher yield over other treatments.

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