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RESEARCH ARTICLE

STUDIES ON DISEASE DYNAMICS OF REDGRAM AND MAIZE IN CONSERVATION AGRICULTURE ECOSYSTEM

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ABSTRACT

Conservation Agriculture (CA), defined as minimal soil disturbance (no-till) and permanent soil cover (mulch) combined with rotations, as a more sustainable cultivation system for the future. Red gram diseases such as wilt, dry root rot and *Cercospora* leaf spot and in maize crop, blight and *Curvularia* leaf spot were assessed by recording per cent incidence, severity and per cent disease index at monthly interval from Conservation Agriculture plot in different treatment such as Zero Tillage With Mulch (ZTWM), Zero Tillage Without Mulch (ZTWTM), raised bed with mulch (RBWM), Raised Bed Without Mulch (RBWTM) and farmers practice (FP). The lowest per cent disease severity of red gram wilt was recorded in the treatment ZTWTM (12.54%), whereas minimum per cent disease index of *Cercospora* leaf spot was observed in RBWTM treatment (10.88%), dry root rot was less in the treatment ZTWTM (22.19) while in maize minimum blight severity was recorded in the treatment ZTWTM (18.30%) and minimum incidence of *Curvularia* leaf spot was recorded in the treatment ZTWTM (11.94%) respectively and wilt, *Cercospora* leaf spot, dry root rot, blight and *Curvularia* leaf spot disease incidence in redgram and maize were more in farmers practice treatment (21.66,21.94,29.86,31.13 and 17.43%) respectively.

INTRODUCTION

Indian agriculture is entering a new phase. The major research and development efforts in the green revolution are focused on enhancing productivity of selected food grains and few other crops. The new challenges demand that efficient resource use and conservation receive high priority to ensure earlier gains can be sustained and further enhanced to meet the emerging needs. Issues of conservation have assumed importance in view of widespread resource degradation problems and the need to reduce production costs, increase profitability and make agriculture more competitive. Over the past three decades or so, internationally, rapid studies have been made to evolve and spread resource conservation technologies like zero and reduced tillage systems, better management of crop residues and planting systems, which enhance conservation of water and nutrients. Conservation Agriculture (CA) which has its roots in universal principles of providing permanent soil cover (through crop residues, cover crops, agro forestry), minimum soil disturbance and crop rotations is now considered the principal road to sustainable agriculture: a way to achieve goals of higher productivity while protecting natural resources and environment. Conservation agriculture is currently practiced on more than 80 million ha worldwide in more than 50 countries and the area is expanding rapidly (FAO, 2002).

Interest in no-tillage and conservation tillage systems is increasing due to scarcity and increasing cost of fossil fuels, periodic food shortages, inclement weather conditions and concerns over soil erosion. Changing the tillage practice can lead to changes in the physical and chemical properties of soil which in turn is likely to influence the occurrence of plant diseases. Key factors in the occurrence of plant diseases include the survival and activity levels of pathogens, host susceptibility and the population of other soil microorganisms. Keeping this background in mind, an investigation was undertaken to study the disease dynamics of red gram and maize to compare the occurrence of disease in Conservation Agriculture treatments with farmers practice.

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MATERIALS AND METHODS

Field experiments were carried out at the research farm of College of Agriculture, Bheemarayanagudi during 2011-13. The College of Agriculture, Bheemarayanagudi is situated in North-Eastern Dry Zone (Zone 2) of Karnataka state (India) at 16^{o} 43' N latitude, 76^{o} 51' E longitude and at an altitude of 389.37 m above mean sea level which receives an average annual rainfall of 660 mm and with altitude of 412 meters above the mean sea level.

The disease incidence of red gram and maize crops which were grown in Conservation Agriculture based management systems were assessed by recording per cent incidence, severity and per cent disease index at monthly interval. The following red gram, diseases like wilt (*Fusarium udum)*, root rot *(Macrophomina phaseolina)* and foliar disease like *Cercospora* leaf spot (*Cercospora cajani)* were recorded .In maize ecosystem, *Turcicum* blight (*Exserohilum turcicum)* and *Curvularia* leaf spot (*Curvularia lunata*) disease incidence was recorded. The Red gram wilt severity was recorded by using 0–3 scale (VishwaDhara and Chaudhary, 2008).

Grade	Category	Description
1	0-10 % wilted plant	Resistant
2	11-30 % wilted plant	Moderately resistant
3	Above 31 % wilted plant	Susceptible

The *Cercospora* leaf spot was scored on red gram crop by following 0-9 scale (Mayee and Datar, 1986).

Grade	Description
0	No symptoms on the leaf
1	Lesion small, pinhead size, covering less than 1 % leaf area
3	Lesions covering 1-10 % of leaf area
5	Lesions enlarged but not coalescing, covering 11-25 % area
7	Lesions coalescing covering 26-50 % leaf area
9	>51 % leaf area covered ,defoliation of leaves

The maize blight severity was recorded on maize crop by following 0-5 scale (Mayee and Datar, 1986).

Grade	Infection type	Reaction
1	0-5 % Very slight to slight infection, one or two to few scattered lesions on lower leaves	Highly resistant
2	5.1-115 % Light infection, moderate number of lesions on lower leaves Only	Resistant
3	15.1-30 % Moderate infection, abundant lesions on lower leaves, few on middle leaves	Moderately resistant
4	30.1-75 % Heavy infection, lesions abundant on lower and middle leaves, extending to upper leaves	Susceptible
5	ery heavy infection, lesions abundant on almost all leaves, plants prematurely dry or killed by the disease	Highly susceptible

The *Curvularia* leaf spot of maize was scored by using 0-4 scale (Mayee and Datar, 1986) and described as

Grade	Description
0	No symptoms on the leaf
1	Lesion small, pinhead size, covering less than 1- 20 % leaf area
2	Lesions covering 21-25 % of leaf area
3	Lesions enlarged but not coalescing, covering 25-50 % area
4	Lesions coalescing covering > 50 % leaf area
5	>51 % leaf area covered ,defoliation of leaves

For above all disease PDI and Per cent Disease incidence was calculated by using the following formula (Wheeler, 1969).

$$\text{Percent Disease Index} = \frac{\text{Sum of individual disease ratings}}{\text{Total no. of plants observed x Maximum grade}} \times 100$$

$$\text{Per cent disease Incidence} = \frac{\text{No. of plants showing wilting symptom}}{\text{Total no. of plants}} \times 100$$

RESULTS AND DISCUSSION

In red gram, the minimum wilt severity was observed in the treatment zero tillage without mulch (6.75, 11.65, 16.97 and 14.8%) at 30, 60, 90 and 100 DAS and whereas severity was more in the farmers practice treatment (15.42, 19.57, 23.97 and 27.7%) at 30, 60, 80 and 100 DAS (Table1 and Fig 1). In case of *Cercospora* leaf spot the per cent disease was maximum in the treatment farmers practice (15.32, 19.75,23.25 and 29.47%) and minimum in raised bed without mulch (5.05,8.62,13.62 and 16.25) followed by zero tillage without mulch (7.32,9.17, 15.92 and 21.57%) respectively (Table 2 and in Fig 2). Similarly, dry root rot was less in the treatment zero tillage without mulch (14.67,20.1, 25.75 and 28.25%) followed by raised bed without mulch (18.85, 21.12, 24.15 and 27.9%) and more in the farmers practice (25.67,27.77, 36.61 and 34.42%) respectively at 30, 60, 90 and 100 DAS (Table 3 and Fig 3). The incidence and severity of several foliar and root pathogens *viz.*, *Septoria tritici* (Speckled leaf blotch or *Septoria* blotch), *Septoria nodorum* (Leaf and glume blotch), *Rhizoctonia solani* (*Rhizoctonia* bare patch or root rot), *Pythium* species (seed and root rot), *Erysiphe graminis*(Powdery mildew), *Fusarium* species causing crown rot of wheat has been reported to be more in conservation tillage. In contrast, *Bipolaris sorokiniana* (foliar blight), *F. culmorum*and *F. avenaceum* incitant of common root rot of wheat were partially or completely controlled by reduced tillage due to increase in soil moisture, disruption of spore movement from straw to crop by large amount of straw and production of dry conditions due to less dense crop canopy that occurred from reduced tillage (Sumner *et al*., 1981; Sturz *et al*., 1997 and Bockus and Shroyer, 1998).

Similarly, Studies in the mid 90s showed that there was significantly less root rot of pea in direct-seeded fields than in conventional-till fields. *Rhizoctonia* root rot was generally more severe when wheat and barley were sown directly into cereal stubble than when sown into a seedbed using conventional tillage (Gill *et al*., 2001). Other diseases, such as common root rot, caused by *Cochliobolus sativus*, were reduced under zero-till while wilts caused by *Fusarium* spp. increased (Bailey *et al*., 2001). However, the uses of modified narrow sowing points that disturb the soil beneath the seed depth consistently reduce the level of *Rhizoctonia* root damage. This is not due to a reduction or elimination of the pathogen, but enhanced root growth in the loose soil which compensates for loss of root mass due to disease. The prevalence of disease in soybeans is less in no-till, than either minimum or conventional-till, but more in minimum than conventional-till.

Table 1. Effect of Conservation Agriculture and farmers practice treatments on severity of red gram wilt under red gram ecosystem

Treatments	Per cent Disease Severity (%) of wilt				
	30 DAS	60 DAS	90 DAS	100 DAS	Mean
Zero tillage with mulch	9.4 (17.82)*	12.77 (20.92)	20.27 (26.74)	24.1 (29.39)	16.63 (22.30)
Zero tillage without mulch	6.75 (14.95)	11.65 (19.94)	16.97 (24.30)	14.8 (22.60)	12.54 (20.44)
Raised bed with mulch	11.05 (19.38)	14.72 (22.56)	12.9 (21.04)	15.60 (23.25)	13.57 (21.55)
Raised bed without mulch	8.8 (17.22)	12.92 (21.02)	16.85 (24.23)	9.52 (26.21)	14.52 (22.17)
Farmers practice	15.42 (23.12)	19.57 (26.25)	23.97 (29.32)	27.70 (31.76)	21.66 (27.61)
S.Em±	0.786	0.839	0.916	0.949	
C.D (0.01)	2.37	2.528	2.76	2.86	

*Figures in parenthesis are arc sine transformed values

Table 2. Effect of Conservation Agriculture and farmers practice treatments on severity of *Cercospora* leaf spot of red gram under red gram ecosystem

Treatments	Per cent Disease Index (%) of *Cercospora* leaf spot				
	30 DAS	60 DAS	90 DAS	100 DAS	Mean
Zero tillage with mulch	11.8 (20.09)*	16.17 (23.61)	20.22 (26.72)	24.75 (29.84)	18.23 (25.06)
Zero tillage without mulch	7.32 (15.64)	9.175 (17.59)	15.92 (23.49)	21.57 (27.68)	13.49 (21.1)
Raised bed with mulch	10.50 (18.89)	14.47 (22.34)	18.22 (25.26)	22.25 (28.13)	16.36 (23.65)
Raised bed without mulch	5.05 (12.97)	8.625 (17.03)	13.62 (21.62)	16.25 (23.77)	10.88 (18.84)
Farmers practice	15.32 (23.01)	19.75 (26.38)	23.25 (28.81)	29.47 (32.87)	21.94 (27.76)
S.Em±	0.724	1.138	1.056	1.042	
C.D (0.01)	2.183	3.43	3.483	3.542	

*Figures in parenthesis are arc sine transformed values

Table 3. Effect of Conservation Agriculture and farmers practice treatments on severity of dry root rot of red gram under red gram ecosystem

Treatments	Per cent disease severity (%) of dry root rot				
	30 DAS	60 DAS	90 DAS	100 DAS	Mean
Zero tillage with mulch	20.5 (26.93)*	22.25 (28.15)	25.5 (32.26)	29.75 (33.68)	24.5 (24.20)
Zero tillage without mulch	14.67 (22.52)	20.1(26.56)	25.75 (30.48)	28.25 (32.09)	22.19 (27.91)
Raised bed with mulch	23.37 (28.92)	26.07 (32.02)	28.3 (33.76)	31.75 (35.52)	27.3 (32.55)
Raised bed without mulch	18.85 (25.72)	21.12 (28.07)	24.15 (32.05)	27.9 (34.402)	23.25 (30.06)
Farmers practice	25.67 (31.10)	27.77 (34.93)	31.61 (37.1)	34.42 (39.48)	29.86 (35.65)
S.Em±	0.651	0.79	1.116	1.41	
C.D (0.01)	1.963	2.382	3.363	4.251	

*Figures in parenthesis are arc sine transformed values

Table 4. Effect of Conservation Agriculture and farmers practice treatments on severity of blight of maize under maize ecosystem

Treatments	Per cent disease severity (%) of maize blight				
	30 DAS	60 DAS	90 DAS	100 DAS	Mean
Zero tillage with mulch	17.47 (26.34)*	22.71 (27.55)	26.39 (30.18)	29.32 (35.90)	23.97 (29.99)
Zero tillage without mulch	12.08 (21.82)	16.51 (24.10)	19.84 (25.21)	24.80 (27.65)	18.30 (32.91)
Farmers practice	22.27 (28.84)	27.28 (30.72)	32.66 (36.80)	42.31 (48.20)	31.13 (36.14)
S.Em±	0.553	0.728	0.911	0.976	
C.D (0.01)	1.642	2.163	2.707	2.9	

*Figures in parenthesis are arc sine transformed values

Table 5. Effect of Conservation Agriculture and farmers practice treatments on severity of *Curvularia* leaf spot of maize under maize ecosystem

Treatments	Per cent Disease Index (%) of *Curvularia* leaf spot				
	30 DAS	60 DAS	90 DAS	100 DAS	Mean
Zero tillage with mulch	7.14 (11.47)*	10.14 (21.39)	14.85 (23.81)	19.3 (26.74)	12.85 (20.85)
Zero tillage without mulch	5.54 (9.74)	12.71 (22.42)	11.28 (21.83)	18.24 (25.43)	11.94 (19.85)
Farmers practice	10.54 (21.57)	15.23 (28.6)	18.85 (27.23)	25.1(30.01)	17.43 (26.85)
S.Em±	0.411	0.432	0.513	0.529	
C.D (0.01)	1.22	1.285	1.524	1.538	

*Figures in parenthesis are arc sine transformed values

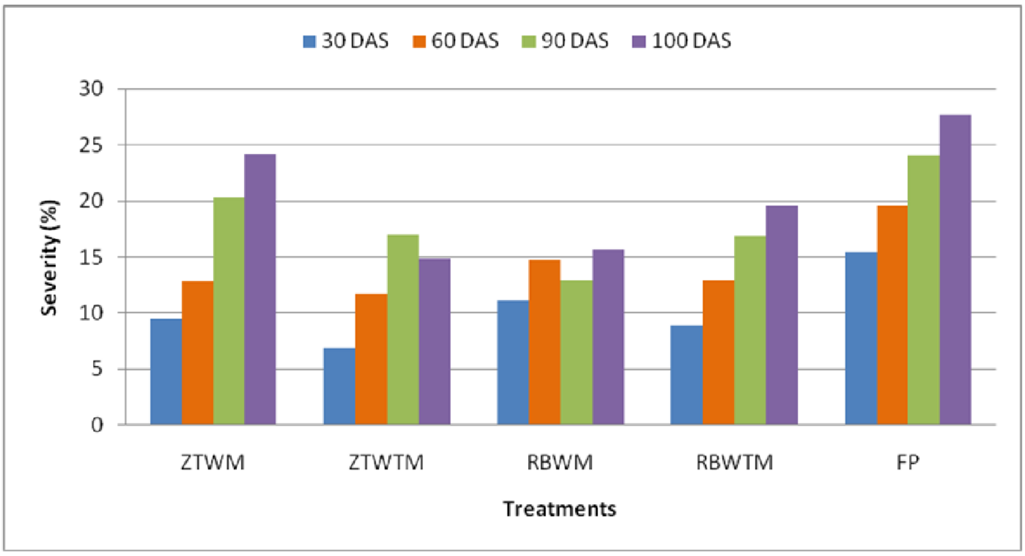

Fig. 1. Effect of Conservation Agriculture and farmers practice treatments on severity of wilt of red gram under red gram ecosystem

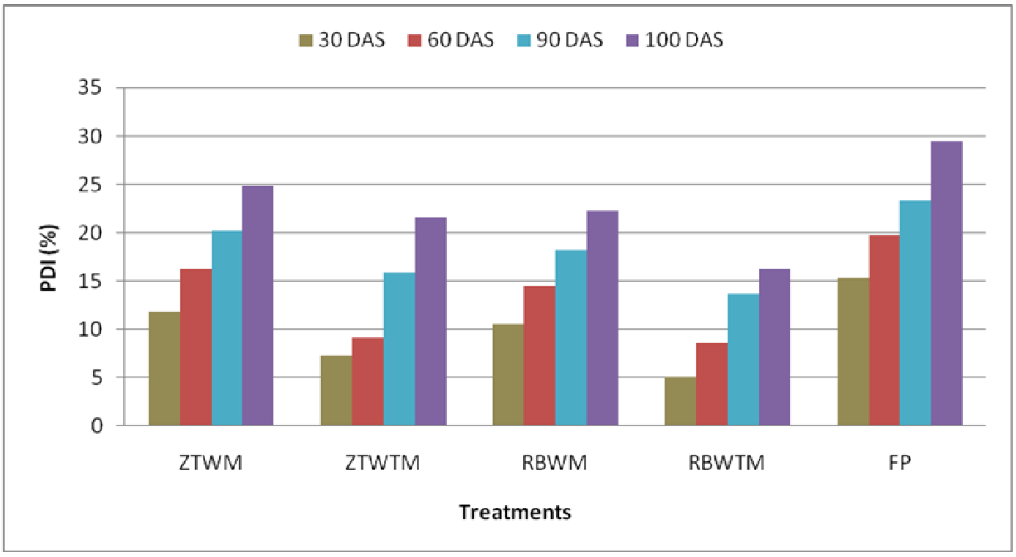

Fig.2. Effect of Conservation Agriculture and farmers practice treatments on severity of *Cercospora* leaf spot of red gram under red gram ecosystem

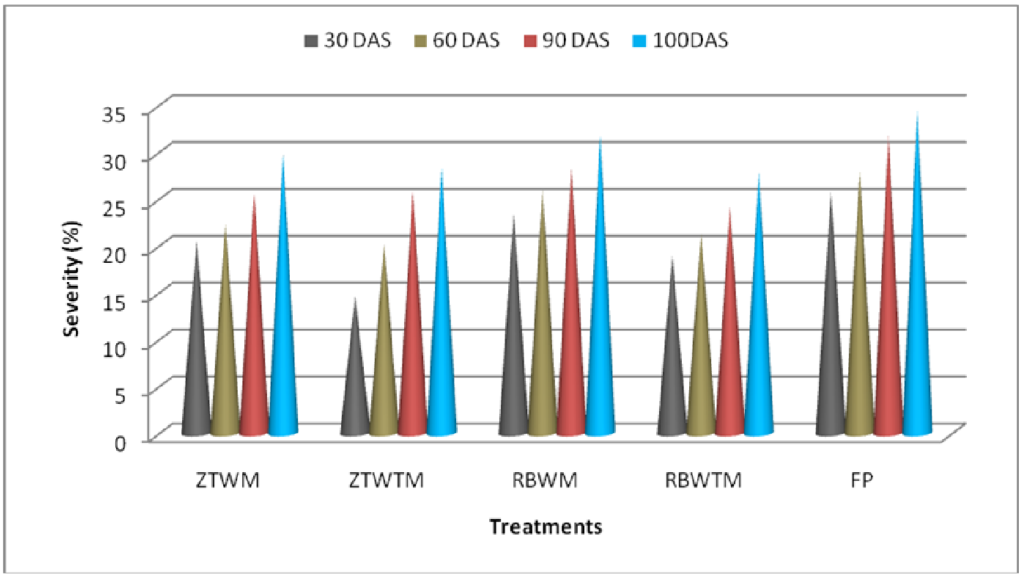

Fig.3. Effect of Conservation Agriculture and farmers practice treatments on severity of dry root rot of red gram under red gram ecosystem

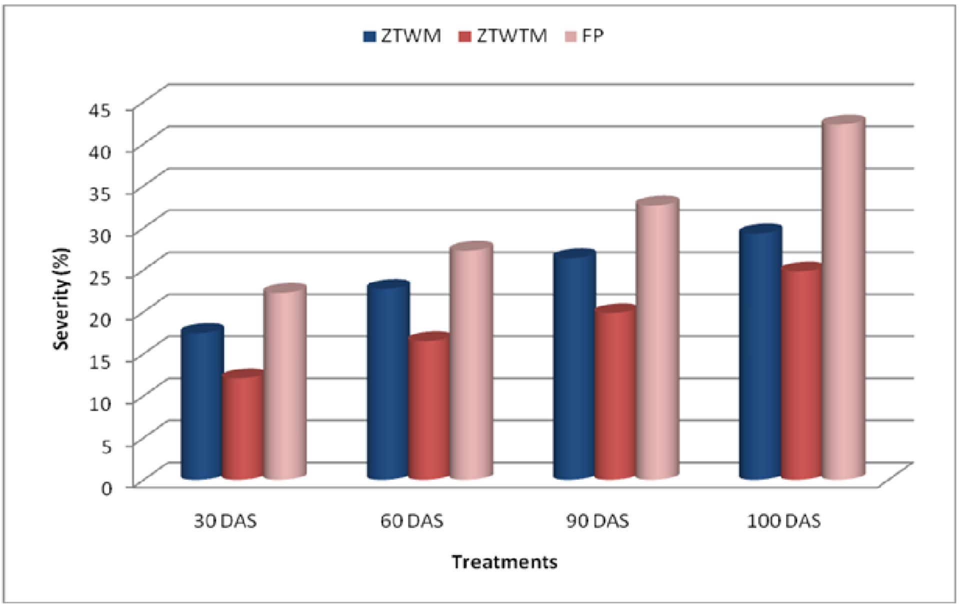

Fig.4. Effect of Conservation Agriculture and farmers practice treatments on severity of blight of maize under maize ecosystem

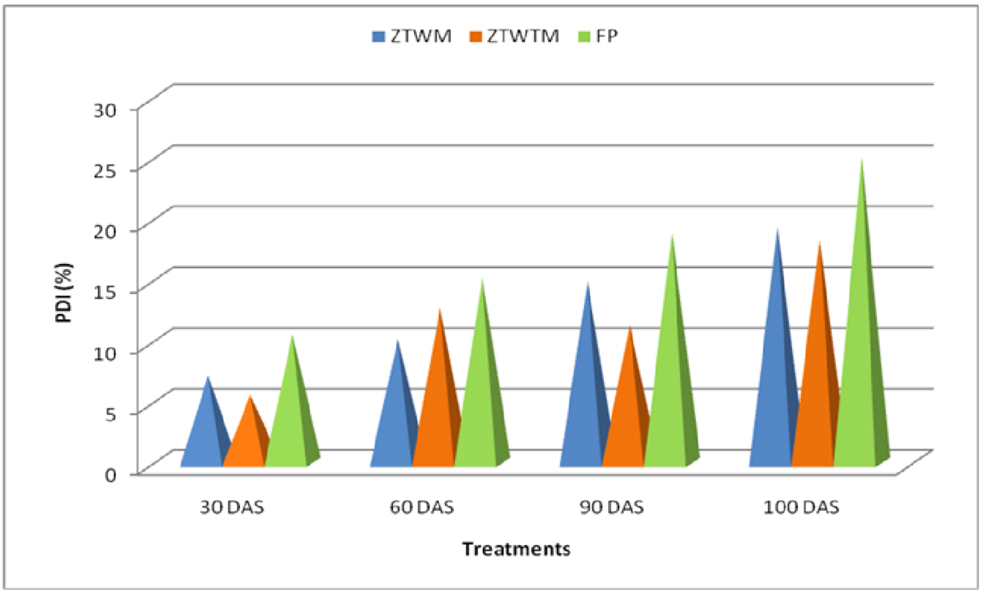

Fig.5. Effect of Conservation Agriculture and farmers practice treatments on severity of *Curvularia* leaf spot of maize under maize ecosystem

Under conventional-till sclerotia that remain deeply buried do not germinate, while under minimum tillage the surface disturbance may release sclerotia from host stems and retain them at the surface or sufficiently close to the surface to germinate and thus provide higher levels of inoculum (Workneh and Yang, 2000). Similarly Workneh and Yang (2000) recorded the commonly isolated leaf spot pathogens that cause tan spot, septoria leaf blotch, *stagonospora nodorum* blotch and spot blotch was more prevalent in no-till fields, *Septoria* leaf blotch and *Stagonospora* leaf blotch less prevalent in conventional till fields and spot blotch present at equal levels in both tillage systems. In a USA study, higher levels of leaf spot diseases were associated with zero-till plots in years with higher than normal precipitation (Cook *et al*., 1978; Reis, 1996). In maize, the blight severity was ranged between 17.47 to 29.32 per cent in the treatment zero tillage with mulch followed by zero tillage without mulch (12.08 to 24.80%) and in farmers practice (22.27 to 31.13%). The minimum blight severity was recorded in the treatment zero tillage without mulch (12.08,16.51,19.84 and 22.80%) and maximum in farmers practice treatment (22.27, 27.28, 32.66 and 42.31%) respectively at 30, 60, 90 and 100 DAS was presented in Table 4 and Fig 4 and in case of *Curvularia* leaf spot the maximum per cent index was observed in farmers practice (10.54,15.23, 18.85 and 25.1%) and minimum incidence was recorded in the treatment zero tillage without mulch (7.14,10.14, 14.85, 11.28 and 19.3%) respectively at 30 DAS, 60 DAS,80 DAS and 100 DAS was recorded (Table 5 and Fig. 5).

Other literature reports that the burial of residue effectively controls take-all (Kollmorgen *et al*., 1985) Rovira and Venn (1985) attributed lower levels of take-all under CT to factors such as the break up and decomposition of wheat roots and the stimulation of microbial activity by cultivation Tillage distributed the inoculum of *Gaeumannomyces graministritici* throughout the cultivated layer and influenced the location of take-all symptoms on wheat roots. The inoculum of the fungus spread only 10 cm in undisturbed soil compared to an average of 0.9 m and as much as 2.5 m following cultivation. There was an increase in the number of leaf spot lesions caused by *Stagnosporatritici* and *Pucciniatritici-repentis* under zero tillage as compared to conventional tillage, whereas *Fusarium* spp. significantly increased under zero tillage. However, mean incidence of foot rot and bakanae and grain discoloration of rice was more in zero tillage plots (6.5 and 14.6%) as against 2.0 and 9.8 per cent in conventionally sown plots. There was no marked difference as far as foliar blight was concerned under ZT and CT (Cartwright *et al*., 1996; Singh *et al*., 2002).

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