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Spatial variability of mungbean yellow mosaic virus (MYMV) in North Eastern Karnataka

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ABSTRACT :

Mungbean a protein rich legume has high demand but, supply is hindered due to poor production and productivity due to mungbean yellow mosaic virus (MYMV) disease. The North Eastern Karnataka being the pulse bowl of the state annually suffers from MYMV incidence. In order to control this whitefly transmitted virus, knowledge and information about its distribution across the region is essential to formulate the strategies of management. In the present study a roving survey was undertaken to know the incidence and present status of MYMV in mungbean among the six districts of North Eastern Karnataka (NEK) region *viz*., Bellary, Bidar, Koppal, Kalaburgi, Raichur and Yadgir during *Kharif* 2016, when the crop was at 30 to 45 days old. The GPS position and MYMV incidence in each location were recorded and used to develop GIS map to know the spatial distribution of MYMV in different talukas of six districts. The results showed varied incidence of MYMV across many locations. Highest disease incidence was recorded at Koppal district with 33.33 per cent followed by Bellary (21.45 %), Raichur (19.70 %), Kalaburgi (17.44 %) and Yadgir (15.76 %) districts. The least disease incidence was noticed at Bidar district (5.66%). Higher MYMV incidence in Koppal was mainly due to favourable weather for multiplication and survival of whitefly population which spreads the virus. The virus inoculum in summer crop and weed hosts were found acting as source of inoculum. Findings of the study revealed that higher incidence in Koppal would provide suitable disease pressure for screening of genotypes developed against the MYMV infection and also develop management strategies in each district based on the disease incidences recorded.

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INTRODUCTION

Mungbean [*Vigna radiata* (L.) Wilczek] also known as greengram is one of the thirteenth food legumes grown in India and third most important pulse crop after

chickpea and pigeonpea. The crop is native to the Indian subcontinent and cultivated in other South East Asian countries (Singh, 1991). There is huge demand for mungbean as a source of dietary protein especially in Asia and other parts of world. India is major consumer and producer of this legume spread across 34.4 lakh ha with the production of 15 lakh tones and productivity of 407 kg ha^{-1}. However, supply is hardly meeting the demand. Annul imports from Myanmar, Burma and African nations is adding to huge exchange losses and increased domestic prices. To resolve crises, increasing area under mungbean is difficult but increasing the production by overcoming constraints is need of the hour. Next to drought, yellow mosaic disease caused by mungbean yellow mosaic virus (MYMV) is the major limiting factor in production and productivity of mungbean across India and in other parts of the world. Its cultivation in Karnataka (India) state occupies an area of 5.28 lakh ha production of 1.08 lakh tones and productivity of 205 kg ha^{-1}. North Eastern Karnataka is major contributor (70%) but, the poor productivity due to yellow mosaic disease has been discouraging the farmers who are keen to grow this short duration drought tolerant legume as catch crop, relay crop, inter crop, crop rotation and often fodder crop also during *Kharif, Rabi* and summer seasons. Apart from mungbean, MYMV also infects soybean, mothbean, cowpea, urdbean and few other leguminous hosts (Dhingra and Chenulu, 1985 and Qazi *et al*., 2007). Crops infected at early stages suffer more with severe symptoms of mosaic, complete yellowing and puckering (Salam, 2011). The virus also causes irregular green and yellow patches in older leaves and yellowing of younger leaves (Nene, 1973). The virus is transmitted by whitefly (*Bemisia tabaci* Genn.) in a persistent, circulative manner (Rosen *et al*., 2015). In order to increase the grain yield and gross returns of mungbean, indentifying the spatial distribution of MYMV disease is essential, which helps in formulating suitable management practices.

MATERIAL AND METHODS

The present investigation on spatial distribution of mungbean yellow mosaic virus (MYMV) was conducted by undertaking a roving survey of North Eastern Karnataka during *Kharif* 2016 covering six districts *viz*., Koppal, Raichur, Bellary, Kalburgi, Yadgir and Bidar. Survey was carried out in major talukas of each district, in each taluka five villages and in each village two plots were surveyed for MYMV incidence. The disease incidence at each plot visited was measured, recorded and scored based on the score chart of Bashir (2005). During the survey other alternate crop hosts and weed hosts of MYMV and symptoms expressed by them were also noted. The global position of each location (longitude and latitude) was noted at each plot visited, using Trimble Juno SB series pathfinder GPS (Global positing system) equipment. Further, GPS readings were used to plot spatial variation map of MYMV incidence in each district using ArcGIS version 10.4 software. The per cent disease incidence during the survey was calculated based on the following formula:

$$\text{Per cent disease incidence (PDI)} = \frac{\text{Number of plants infected}}{\text{Total number of plants observed}} \times 100$$

Table A : Disease score chart based on the incidence (%)

Disease severity	Incidence (%)
0	All plants free of disease symptoms
1	1 - 10% Infection
2	11 -20% infection
3	21-30% infection
4	30-50 % infection
5	More than 50%

RESULTS AND DISCUSSION

The survey conducted across twenty talukas of six districts of NEK region revealed the ubiquitous presence of MYMV on mungbean in the region (Table 1). Overall MYMV incidence ranged from 5.66 to 33.33 per cent across different places visited (Fig. 2). The disease incidence recorded during the survey along with GPS readings when potted to draw the map showed variability in spatial distribution of MYMV in different talukas. Disease incidence varied from location to location, but higher incidence was noticed across many locations (Fig. 1). The maximum average incidence at district level was found in Koppal (33.33%) district (Table 2) followed by Bellary (21.45%) district. Minimum average incidence was observed in Bidar (5.66%) district with. During survey, some of the crop and weed hosts of MYMV like cowpea, blackgram, *Croton* spp., *Euphorbia geniculata, Amaranthus* spp., *Ageratum conyzoides*, pigeonpea and mesta, were noticed in and around the mungbean plots and also nearby bunds showing mosaic,

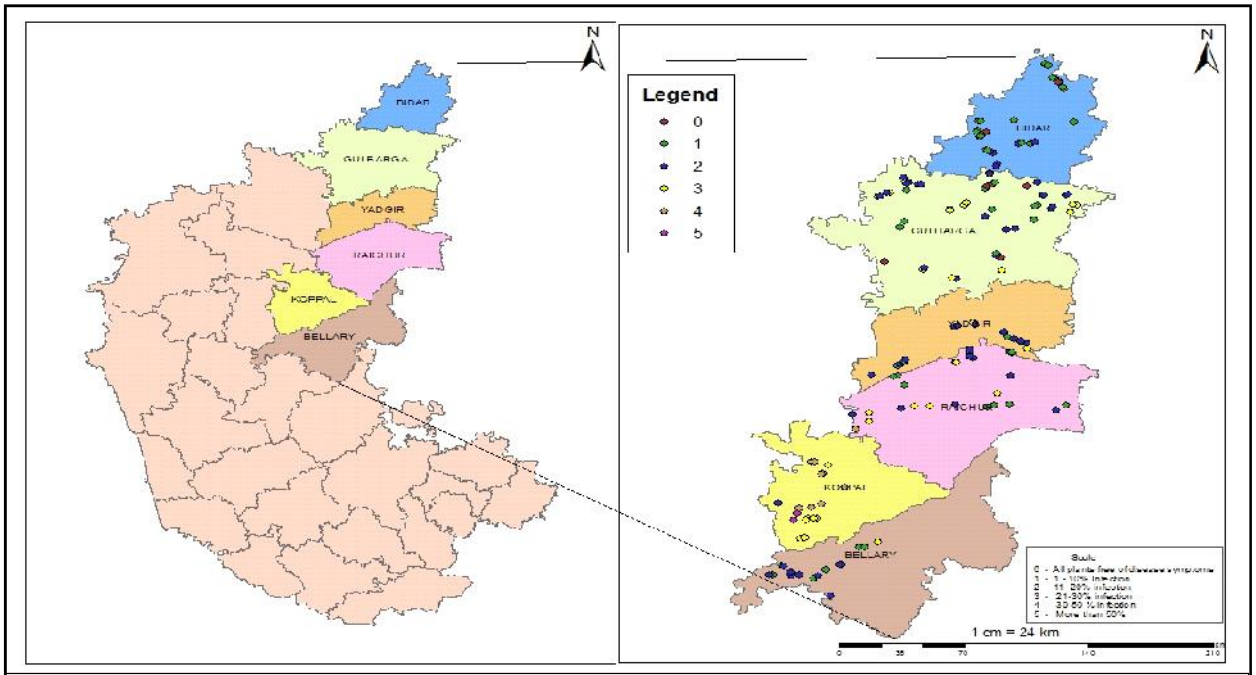

Fig. 1 : Spatial variation of MYMV incidence on mungbean during *Kharif* 2016 in North Eastern Karnataka region

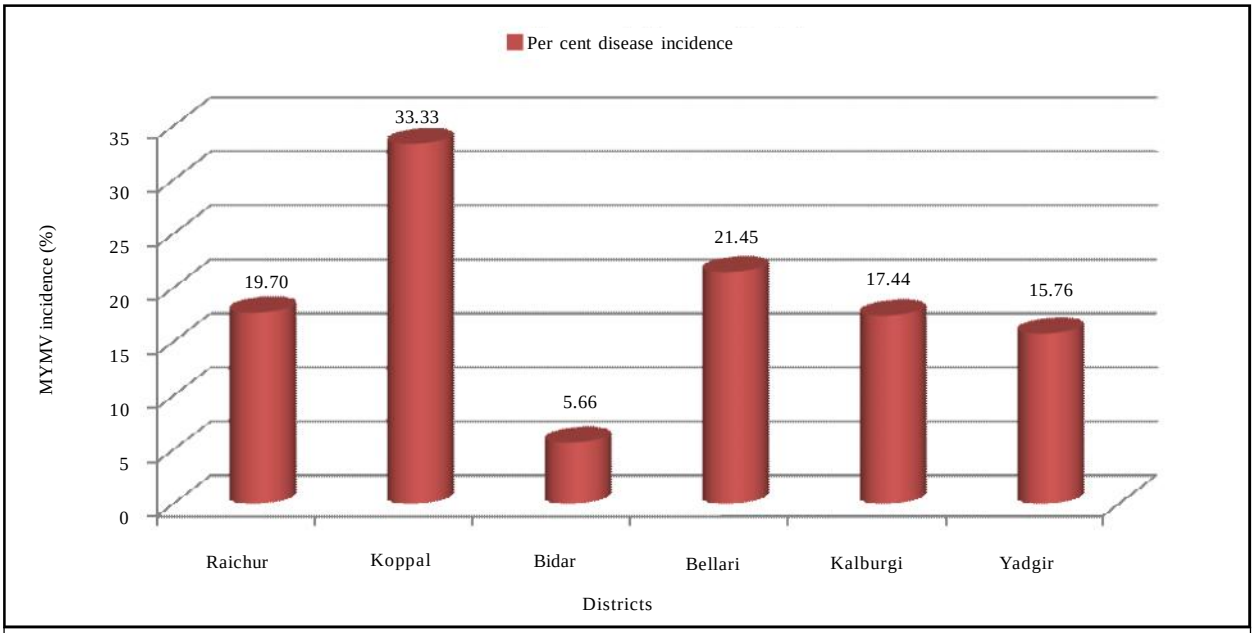

Fig. 2 : Prevalence of MYMV on mumgbean in six districts of North Eastern Karnataka during *Kharif*, 2016

mottling, yellowing, vein clearing and vein thickening etc. (Table 3). These acts as alternate hosts for the survival of the virus during the off season (Varma *et al*., 1992; Usharani *et al*., 2004 and Malathi *et al*., 2005) transmitted by whiteflies. Survey showed the highest incidence of MYMV in Koppal district which could be termed as hot spot for MYMV irrespective of cultivars sown. Higher temperatures during May and April also favour the vector buildup (Murugesan and Chelliah, 1977) and whiteflies population has positive correlation with

Table 1: Spatial variation of MYMV incidence and its severity in six districts of NEK during *Kharif*, 2016

District	Taluka	Village	Latitude	Longitude	PDI (%)	Severity scale	District	Taluka	Village	Latitude	Longitude	PDI (%)	Severity scale
Bidar	Aurad	Hokrana	18.377201	77.327871	7	3	Kalaburgi	Aland	Mogha K	17.498103	76.442831	21	1
			18.381518	77.326927	4	2				17.504857	76.450341	18	1
		Savargaon	18.379075	77.352633	0	0			Jidga	17.522997	76.501957	24	1
			18.371459	77.344651	2	1				17.526005	76.489769	14	1
		Ekamba	18.278213	77.375494	2	1			Honnalli	17.590041	76.602417	15	1
			18.287097	77.372275	6	2				17.585296	76.594434	17	1
		Ganeshpur	18.266430	77.396053	5	1			Telekuni	17.615855	76.573117	22	2
			18.260684	77.401203	0	0				17.625314	76.573835	20	1
		Boral	18.213556	77.427654	6	1			Munnahalli	17.578398	76.652174	14	1
			18.224074	77.423878	8	1				17.580208	76.667698	11	2
		Tadola	17.808530	77.013034	6	1			Sulepeth	17.415629	77.357789	15	1
			17.802565	77.018356	7	1				17.427667	77.366114	19	1
	Basavakalyan	Yedlapur	17.892713	76.982676	8	1		Chincholli	Tajlapur	17.506757	77.313875	22	1
			17.900799	76.985766	4	1				17.504659	77.318762	20	2
		Dhannur K	17.923483	77.011944	3	1			Fatehapur	17.507590	77.432962	14	2
			17.927076	77.015570	0	0				17.510816	77.448040	17	2
		Balkunda	17.938438	76.969946	3	1			Somalingadahalli	17.395458	77.458224	22	1
			17.929252	76.965226	6	1				17.393734	77.460012	25	2
		Devanal	18.001998	76.976277	9	1			Chikkalingadahlli	17.439540	77.493364	28	1
			18.000794	76.983701	3	1				17.445864	77.471460	24	1
		Madakatti	17.541887	76.594108	3	1			Kankurthy	16.563414	77.122913	15	2
			17.541893	76.594109	3	1				16.590458	77.104694	10	1
	Bhalki	Dannur	17.553518	77.005286	0	0		Chittapur	Mandgalli	16.590554	77.104776	20	3
			17.553520	77.005287	2	0				16.590588	77.104779	15	2
		Muchalamba	17.570495	77.021853	0	0			Konganda	16.595587	77.102798	20	2
			17.581830	77.045692	0	0				16.595596	77.102799	20	1
		Halagota	17.591916	77.060049	5	1			Hattikuni	16.595610	77.102680	15	2
			17.591920	77.060053	2	0				16.595617	77.102689	18	1
		Badjawalga	17.090704	77.090704	5	1			Bankalaga	17.004520	77.095755	20	2
			17.090706	77.090786	0	0				17.004521	77.095757	23	2

Table 1 : Contd.....

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	Bidar	Gumtapur	18.003600	77.163464	12	1		Jevargi	Kurikota	17.295631	76.555475	10	1
			18.004321	77.163459	5	1				17.295639	76.555512	10	1
		Khanapur	17.565149	77.231850	2	1			Kalbenur	17.333183	76.580632	10	1
			17.565151	77.231862	0	0				17.365197	77.010095	12	1
		Janvad (KVK)	17.590590	77.285943	15	1			Hallikhed	17.412117	77.040916	10	1
			17.995589	77.480618	8	1				17.063840	76.473587	0	0
		Bhangur	17.435979	77.281976	2	1			Andola	16.948781	76.855275	17	1
			17.431318	77.273926	3	1				16.955596	76.830170	21	2
	Humnabad	Salebeernalli	17.341098	77.262388	3	1		Kalaburgi	Harwal	17.016217	76.677605	24	3
			17.431368	77.273851	5	1				17.024219	76.686231	18	1
		Hallikhed - B	17.849700	77.250518	8	1			Malakhed	17.100057	77.062850	14	3
			17.861465	77.275924	12	1				17.100927	77.062736	11	1
		Dubbalgundi	17.850517	77.184600	11	1			Dandothi	17.121067	77.064111	15	2
			17.855583	77.205199	6	1				17.121068	77.064111	10	1
		Rajeshwar	17.787026	77.051562	14	1			Awarad B	17.440560	76.896517	25	1
			17.797242	77.032508	18	1				17.454823	76.905878	22	1
		Hallikhed K Wadi	17.713612	77.071679	12	1			Tajsultanpur	17.413927	76.818680	25	2
			17.697423	77.067473	15	1				17.403794	76.819980	22	2
		Dongergaon	17.654217	77.031485	10	1			Tengali	17.282595	77.164621	20	2
			17.647510	77.033631	13	1				17.277964	77.119260	18	2
Bellary	Hagari bommanahlli	Itagi	14.957565	76.102424	18	1	Raichur	Lingasugur	Ameengad	16.061068	76.392904	25	2
			14.960126	76.104666	23	1				16.101905	76.711680	28	2
		Nellakuduri	14.971848	76.124815	20	1			Chickhesarur	16.044932	76.305447	15	2
			14.973165	76.126531	17	2				16.101328	76.631429	21	1
		Ulavatti	15.010862	76.169420	12	1			Kuppigudda	16.647045	71.305315	10	2
			15.012272	76.167703	20	1				16.647051	71.305310	15	2
		Ballhunasi	15.049759	76.247785	11	1			Karadkal	16.024516	76.274361	30	2
			15.049847	76.243949	16	2				16.024520	76.274366	32	2
		Marammanahalli	15.168140	76.341206	10	1			Hunkunti	15.565052	76.263978	40	3
			15.168015	76.369230	8	1				15.565055	76.263979	45	2

Table 1 : Contd..........

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Koppal	Huvinahadagali	Uttangi	14.583113	76.011040	35	2
			14.982130	76.028974	23	2
		Sogi	14.583167	76.011319	30	2
			14.976160	75.985715	37	2
		Dasarahalli	15.039415	75.936963	23	1
			15.037094	75.948379	26	2
		Mudenur	14.994898	75.988721	32	2
			14.993903	75.981767	28	2
		Thippapur	14.978647	75.889087	18	1
			14.979104	75.872762	22	2
		Hiresindogi	15.201802	76.440194	20	3
			15.201802	76.440200	25	2
	Koppal	Budihal	15.170011	75.055415	18	1
			15.170019	75.055417	20	2
		Wadaganal	15.355568	76.073363	26	2
			15.342904	76.064651	25	2
		Dadegal	15.353724	76.120899	28	3
			15.357138	76.103594	30	3
		Betageri	15.219444	76.036698	25	2
			15.229383	76.057641	27	3
		Ankalimat	15.565006	76.264014	10	1
			15.565007	76.264019	15	2
	Kushtagi	Byalihal	15.454055	76.143099	45	3
			15.454067	76.143099	43	3
		Nerebenchi	15.711859	76.180043	35	3
			15.712685	76.178241	29	3
		Hirebannigol	15.730221	76.090934	36	3
			15.729891	76.107028	32	4
		Mandalamari	15.652728	76.152049	41	4
			15.645953	76.142318	46	4
		Bandi	15.431673	76.090320	20	3
			15.431675	76.090330	35	3
	Yelburga	Tumurguddi	15.424784	76.030143	50	4
			15.424788	76.030148	46	3
		Malaksamudra	15.424746	76.030044	30	3
			15.424755	76.030047	32	3
		Vangera	15.390660	76.014382	50	3
			15.390670	76.014388	52	3
		Sanganal	15.344885	76.001696	50	3
			15.344885	76.001698	53	3
Yadgir	Shorapur	Maremma camp	16.115559	77.132638	8	1
			16.115341	76.846296	12	1
		Attur	16.110129	77.052017	7	1
			16.110150	77.519337	12	2
		Mallat	16.085076	76.564452	10	3
			16.085078	76.564453	20	3
		Jakkalidinni	16.105793	77.428873	21	2
			16.105982	77.428893	10	2
		Tippaldinni	16.095649	77.012864	10	1
			16.186077	77.068383	23	2
		Rasthapur	16.629364	76.841403	12	1
			16.636539	76.859792	15	1
	Shahapur	Gudagurthi	16.656627	76.943011	21	1
			16.644662	76.952517	19	1
		Hundekal	16.395230	76.571252	50	1
			16.395476	76.571568	20	2
		Hoskere	16.403471	76.581555	8	1
			16.403478	76.581556	8	1
		Khanpur	16.410188	76.584285	12	2
			16.410178	76.584207	11	1
		Gurmitkal	16.485654	77.224075	25	3
			16.521744	77.221087	17	3
		Dharmapur	16.530414	77.194054	10	1
			16.530459	77.194056	15	2
		Bettadhalli	16.532536	77.192590	40	3
			16.532541	77.192593	10	1
		Chepetla	16.552919	77.155642	18	2
			16.312502	76.402772	12	1
		Gajarkot	16.563392	77.122970	20	1
			16.301426	76.523389	10	1
		Hattigudur	16.372589	76.542378	10	1
			16.372589	76.542382	8	1
	Yadgir	Beemuru	16.384917	76.554686	18	2
			16.384922	76.554690	12	1
		Tadibidi	16.410178	76.584207	11	2
			16.410208	76.584495	8	1
		Ramasamudra	16.460298	77.143977	20	3
			16.455941	77.145022	10	1
		Munderga	16.462944	77.134733	15	3
			16.460273	77.144128	8	2

maximum temperature (Khan *et al.*, 2012). Interestingly, Koppal district has the highest area under mungbean followed by Bidar and Kalaburgi districts. After summer, mungbean is the first crop sown in *Kharif* season during last week of May to first week of June and it will be the only crop host available for survival of whiteflies and thus virus gets transmitted to mungbean from weed and alternate hosts.

Higher incidence in Koppal district followed by Bellary was also due to availability of inoculum from alternate crop hosts such as cowpea and blackgram grown during summer. Weeds like *Croton Sparciflora*, *cucurbit* spp. and *Euphorbia geniculata* which were previously confirmed and reported as alternative hosts of MYMV by Borah and Dasgupta (2012) also acts as alternate source of MYMV for transmission by whiteflies. In back waters of Tunga Bhadra reservoir, blackgram, cowpea and mungbean are cultivated during summer under irrigated conditions, these crops also get infested and inoculum gets transmitted to next succeeding *Kharif* sown mungbean under rain fed situations. During offseason, whiteflies were found to survive on weed hosts and other legume crops. Higher magnitude of disease might be also due to cultivation of local land races, susceptible varieties with poor awareness of plant protection measures among the growers. None of the

Table 2 : Incidence of MYMV on mungbean in six districts of North Eastern Karnataka region during *Kharif* 2016

District	Taluka	Taluka mean incidence (%)	District mean incidence (%)
Bellary	Hagari bommanahalli	15.50	21.45
	Huvina Hadagali	27.40	
Bidar	Aurad	4.00	5.66
	Basavakalyan	4.90	
	Bhalki	2.00	
	Bidar	5.50	
	Humnabad	11.90	
Koppal	Koppal	24.40	33.33
	Kustagi	33.20	
	Yelburga	42.40	
Kalaburgi	Aland	17.60	17.44
	Chincholli	20.60	
	Chittapur	17.60	
	Jevargi	13.20	
	Kalaburgi	18.20	
Raichur	Lingasugur	26.10	19.70
	Raichur	13.30	
	Shahapur	17.60	
Yadgir	Shorapur	17.70	15.76
	Yadgir	12.00	

Table 3: Common crop and weeds species with symptoms of MYMV observed during the survey

Crops	Symptoms observed	Weed hosts	Symptoms observed
Pigeonpea	M, Y	*Croton sparciflora*	M, Y, Vc
Mesta	M, Mt	Wild cucurbit spp.	M, Y
Cowpea	M, Y, P,Vt, Vc	*Amaranthus* spp	M, Mt
Blackgram	M, Mt, Y, Vt, Vc	*Euphorbia* geniculata spp.	Mt
		Ageratum conyzoides	M, Y
		Acalypha indica	M, Y

M: Mosaic, Mt: Mottling, Y: Yellowing, P: Puckering, Vt: Vein thickening, Vc: Vein clearing

farmers were found practicing seed treatment of insecticides against the whitefly vector which is often recommended.

Lower incidence of MYMV during the survey was noticed in Bidar district (5.66%) followed by Yadgir (15.76%) and Kalaburgi (17.44%), it was mainly due to unfavorable weather factors like lower temperature and higher rainfall which are detrimental to whitefly development and multiplication. Gupta *et al.* (2009) also reported a negative correlation between whitefly and rainfall in their survey studies. Bidar district has the cooler temperature and higher rainfall during *Kharif* than any other districts which is detrimental to vector perpetuation and restricted spread of MYMV. Previous surveys carried have also concluded variable incidence of yellow mosaic. Singh *et al*., 1979 reported the MYMV incidence ranging from 70 to 100 per cent in different mungbean growing areas of Hariyana. Salam *et al*. (2011) reported higher incidence of MYMV in different districts of Karnataka *viz*., Bidar (22.64%) and Kalaburgi (17.6%) districts followed by Haveri (9.52%), Dharwad (7.05%) and Gadag (2.61%). Panduranga *et al*. (2012) reported MYMV in Warangal district of Andra Pradesh during vegetative stage (49.6%) and flowering (57.70%) stages, while in Khammam district, 42.20 per cent and 50.62 per cent, respectively. In our study, majority of incidence was noticed in vegetative stage followed by flowering stage. Manjunath *et al*. (2013) also reported 31.49 to 100 per cent incidence of MYMV in Southern Karnataka and diverse spread was due to varying climatic conditions. Higher incidence of MYMV disease in NEK districts could be correlated to higher temperature and dry climate prevailing in these districts favors vector population and its migration behaviour (Singh and Gurha, 1994 and Nath and Saikia, 1995).

Koppal, Bellary and Raichur districts being in semi arid region have favourable climatic conditions especially dry weather before and during the initial crop season congenial for whitefly perpetuation and spread of MYMV. Identical rainfall pattern, cropping systems, close proximity of districts and large area under mungbean in these districts were also responsible for higher disease incidence. Other crops such as cotton, sunflower, mungbean and blackgram which are cultivated in one or the other season also acts as alternate hosts for whitefly and few of them to MYMV also. Bt cotton cultivation in Koppal begins in February under irrigated conditions, hence whiteflies gets their most preferred host before mungbean is sown. Koppal district hosts many seed companies engaged in seed production of vegetables and field crops such as tomato, chilli, capsicum, bell pepper, okra, cucurbits, Bt cotton, sunflower, hybrid maize and other flower crops. All these crops cultivated in either one of the season throughout the year may also provide shelter for continuous multiplication of whiteflies and survival of MYMV in alternate crops or weed species.

Conclusion:

The study concludes that management of MYMV could be done depending upon the incidence level, the spatial distribution helps in making suitable decision such as preventive measures, control measures, spray schedules, precautionary measures and other relevant practice directed towards lowering the MYMV incidence and enhancing the production and productivity of mungbean.

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