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Survey on soil borne diseases of groundnut (*Arachis hypogaea* L.) in Andhra Pradesh

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Abstract
Groundnut is an important oil seed, self-pollinating leguminous crop. Which is affected by several fungal, viral and phytoplasma diseases. Among soil borne diseases *viz*., collar rot, dry root rot and stem or pod rot are important as they cause the heavy yield loss from seedling to harvesting. In this study an attempt was made to assess the incidence and distribution of the above said soil borne diseases in various regions of the Andhra Pradesh. A roving survey was conducted during *Kharif*-2020 and *Rabi* 2020-21 in major groundnut growing areas of the Rayalaseema region of Andhra Pradesh. The groundnut cultivar Kadiri-6 was grown predominantly in all the surveyed locations. During *Kharif*-2020 the maximum incidence of collar rot was recorded in SPSR Nellore (5.4%) district, where as lowest incidence was observed in Kurnool (3.0%) district. The maximum dry root rot incidence was recorded in the Anantapuramu (8.9%) district, whereas as lowest incidence was observed in Chittoor district (6.7%). The maximum stem rot incidence was recorded in the Anantapuramu (6.8%) district, whereas as lowest incidence was observed in SPSR Nellore district (5.4%). In *Rabi* 2020-21 the maximum incidence of the collar rot was recorded in Anantapuramu (7.7%) district, where as lowest incidence was observed in Kurnool district (2.3%) district. The maximum dry root rot incidence was recorded in the Chittoor district (9.9%) district, whereas as lowest incidence was observed in SPSR Nellore district (5.6%). The maximum stem rot incidence was recorded in the Anantapuramu (7.9%) district, whereas as lowest incidence was observed in Kurnool district (3.6%).

Keywords: Soil borne diseases, survey, dry root rot, stem rot, groundnut

Introduction
Groundnut (*Arachis hypogaea* L.) is an important oilseed legume crop of India. It is a major oilseed crop contributing about 36% of the oil seed production of the world. Apart from the oil production, it can be used as food and fodder for cattle. The crop can be grown better in temperate, tropical and sub-tropical climates in the world. Among the oil seed crops in India the groundnut is major oil seed crop cultivated in our country. Groundnut seeds are rich in oil content of about 35-56%, proteins 25-30%, carbohydrates 9.5-19.0%, vitamins (E,K and B) and minerals (P, Ca, Mg and K) (Gulluglu *et al*., 2016 and Hawaladar *et al*., 2021) [4, 6].

The major groundnut growing states in India includes the Gujarat, Andhra Pradesh, Tamil Nadu, Rajasthan and Maharashtra contributing around 90% of the total area and production. Among the soil borne diseases, collar rot (*Aspergillus niger* Van Tieghem), dry root rot (*Rhizoctonia bataticola* (Taub.) Butler) Pycnidium stage (= *Macrophomina phaseolina* Tassi Goid) and stem rot (*Sclerotium rolfsii* Sacc. teleomorph= *Athelia rolfsii*) have been identified as major soil borne diseases which affecting the groundnut from seedling to maturity stages.

These seed and soil borne diseases infecting the groundnut causes the severe seedling mortality resulting in the poor crop stand. The occurrence of these diseases was noticed more in the sandy loamy soils compared to the clay or heavy soils and leading to the heavy yield loss up to 25-50% and even high when conditions are favorable. So, the present work was carried out to know the occurrence, distribution and current status of soil borne diseases in major groundnut growing districts of Andhra Pradesh.

Materials and Methods

Survey

A roving survey was conducted during *Kharif*-2020 and *Rabi*-2020-21 in major groundnut growing areas of different districts of Andhra Pradesh *viz*., Anantapuramu, Chittoor, YSR Kadapa, Kurnool and SPSR Nellore. In each district a minimum of two mandals were selected and on each mandal two villages were selected for survey. On each field the data was taken from five random spots using quadrants. The pooled or average data from these five quadrants were taken as one representative sample data for one field. The plants showing the typical symptoms of collar rot, dry root and stem rot were counted and the percent diseases incidence (PDI) was calculated with the following formula.

$$\text{Percent disease incidence (PDI)} = \frac{\text{No. of. Infected plants}}{\text{Total No. of plants}} \times 100$$

Apart from this, the other information pertaining to name of variety, age of the crop, rainfed/irrigated etc. were recorded.

Results and Discussion

Symptoms

Collar rot

The collar rot caused by the *Aspergillus niger* was noticed mostly at 15-25 days after sowing (DAS). The collar rot symptoms were observed as pre-emergence seedling rot and, on the seedlings, as blackish testa, rotten internal tissue on affected seedlings (Fig.1a). In case of the emerging cotyledons blackish mycelium and rotten tissue will be seen. On the plants the symptoms were appeared as yellowing, drying of the plants (Fig.1b) and presence of the blackish powdery mass near the collar region if the one month old plants (Fig.1c). If up root these plants the blackish powdery mass of *Aspergillus* mycelium can be observed on the young seedling (Fig.1c). Similar type of symptoms were observed

Dry root rot

The dry root rot caused by the *Rhizoctonia bataticola* (Pycnidium stage= *Macrophomina phaseolina*) can be observed from sowing to the maturity of the plants but 30-45 days aged crop is prone to attack when was are prolonged dry spells occurs. Symptoms of dry root rot was observed *viz*., withering, complete wilting and drying of plants (Fig 2a, 2b). When such plants up rooted having blackening of tap root, splitting of the bark into different portions and presence of blackish or greyish minute sclerotia (Fig.2c).

Stem rot

The stem rot symptoms incited by *Sclerotium rolfsii* (teleomorph: *Athelia rolfsii*) can be noticed from any stage of the crop like the seedling to the maturity. The maturity stage crop (75 days old) was more vulnerable to the attack by the pathogen and causes heavy loss. The symptoms of the stem rot were observed as yellowing, partial wilting, complete wilting and loss of vigour, and presence of the white cottony mycelium near the base of the plant, on pegs and pods apart from this white mycelium there was small minute mustard seed shaped sclerotia are also present near the base of stem rot affected plant (Fig. 3a, 3b, 3c).

Fig 1a: Drying and wilting of the plants at 25- 30 DAS.

Fig 1b: Fig 1c: Presence of blackish mycelium with the conidia near the collar region of the infected plant & on the uprooted plants.

Fig 2a: Fig 2b: Complete wilting & drying of the individual plants in the field.

Fig 2c: Pinkish discoloration of mycelium with the small black microsclerotia on split opened dry root infected plant.

Fig 3a: Fig 3b: 3c: Yellowing and partial wilting & Presence of the white mycelium and sclerotial bodies on the collar region of the stem, roots and pods near the ground.

During *Kharif*-2020 in Anantapur district the highest mean incidence of collar rot was recorded in Kadiri (7.0%) mandal, while lowest average incidence noticed in Gooty (1.5%) mandal. The highest average dry root rot incidence was recorded in the Kadiri (10.8%) mandal, while the lowest average incidence was noticed in Talupula (5.9%) mandal. The highest average stem rot incidence was recorded in the Talupula (10.9%) mandal, while the lowest average incidence was noticed in Mudigubba (3.5%) mandal. The overall collar rot, dry root rot and stem rot incidence was recorded as 4.2, 8.9 and 6.9% respectively in Anantapuramu district (Table.1).

In Chittoor district the highest average collar rot incidence was recorded in Pileru mandal (10.4%), while lowest average incidence noticed in Vayalpadu (1.0%) mandal. The highest average dry root rot incidence was recorded in Mulakalacheruvu (10.3%) mandal, while the lowest average incidence was noticed in Vayalpadu (3.1%) mandal. The highest average stem rot incidence was recorded in the Pedda Tippa Samudram (P.T.M) (7.2%) mandal, while the lowest average incidence was noticed in Vayalpadu (1.5%) mandal. The overall mean incidence of collar rot, dry root rot and stem rot was recorded as 3.8, 6.7 and 3.5% respectively in the district of Chittoor (Table.1).

In YSR Kadapa district the highest average collar rot incidence was recorded in Thondur mandal (6.7%), while lowest average incidence noticed in Lakkireddipalli (1.6%) mandal. The highest average dry root rot incidence was recorded in Veerapanayani Palli (VNP) (11.6%) mandal, while the lowest average incidence was noticed in Chinnamandem (4.0%) mandal. The highest average stem rot incidence was recorded in the Rayachoti (12.4%) mandal, while the lowest average incidence was noticed in Chinnamandem (1.7%) mandal. The district mean incidence of collar rot, dry root rot and stem rot was recorded as 3.5, 7.2 and 6.0% respectively (Table.1).

In Kurnool district the highest average collar rot incidence was recorded in Peapally mandal (6.6%), while lowest average incidence noticed in Gonegandla (0.9%) mandal. The highest average dry root rot incidence was recorded in Devanakonda (16.0%) mandal, while the lowest average incidence was noticed in Gonegandla (0.9%) mandal. The highest average stem rot incidence was recorded in the Devanakonda (8.5%) mandal, while the lowest average incidence was noticed in Krishnagiri (0.6%) mandal. The district mean incidence collar rot, dry root rot and stem rot was recorded as 3.0, 7.3 and 3.6% respectively (Table.1).

In SPSR Nellore district the highest average collar rot incidence was recorded in Sangam mandal (9.4%), while lowest average incidence noticed in Vidavalur (2.0%) mandal. The highest average dry root rot incidence was recorded in Sangam (12.9%) mandal, while the lowest average incidence was noticed in Muttukur and Bogolu (4.1%) Mandals. The highest average stem rot incidence was recorded in the Kovur (6.9%) mandal, while the lowest average incidence was noticed in Podalakur (0.4%) mandal. The mean incidence of collar rot, dry root rot and stem rot incidence was recorded as 5.4, 7.3 and 3.5% respectively (Table.1).

It was evident that the maximum collar rot incidence was recorded in the SPSR Nellore district (5.4%) followed by the Anantapuramu (4.2%). The Minimum collar rot incidence was observed in the Kurnool district (3.0%). The maximum dry root rot incidence was recorded in the Anantapur district (8.9%) which is followed by the SPSR Nellore and Kurnool (7.3%). The Minimum dry root rot incidence was observed in Chittoor district (6.7%), during *Kharif* 2020 based on the incidence in five districts (Table.1)

Similarly, the maximum stem rot incidence was recorded in the Anantapuramu district (6.9%) which is followed by the YSR Kadapa district (6.0%) and minimum stem rot incidence was observed in the SPSR Nellore and Chittoor districts (3.4%) (Table.1).

During *Rabi* 2020-21 in Anantapuramu district the highest mean collar rot incidence was recorded in Kadiri (9.6%) mandal, while lowest mean incidence noticed in Talupula (4.1%) mandal. The highest mean dry root rot incidence was recorded in the Puttaparthy (12.0%) mandal, while the lowest mean incidence was noticed in Talupula (4.1%) mandal. The highest mean stem rot incidence was recorded in the Nallamada (13.7%) mandal, while the lowest mean incidence (4.0%) was noticed in Talupula mandal. The overall collar rot, dry root rot and stem rot incidence was recorded as 7.9, 3.7 and 8.0% respectively in Anantapur district (Table.2).

In Chittoor district the highest mean collar rot incidence was recorded in Sadum mandal (11.1%), while the lowest mean

incidence noticed in Rompicherla (2.3%) mandal. The highest mean dry root rot incidence was recorded in Pedda Tippa Samudram (P.T.M) (15.1%) mandal, while the lowest mean incidence was noticed in Somala (6.5%) mandal. The highest mean stem rot incidence was recorded in the B. Kothakota (11.9%) mandal, while the lowest mean incidence was noticed in Pedda Tippa Samudram (P.T.M) (1.1%) mandal. The district mean incidence of collar rot, dry root rot and stem rot was recorded as 5.1, 9.9 and 4.6% respectively (Table.2).

In YSR Kadapa district the highest mean incidence of collar rot was recorded in Vempalli (5.8%) mandal, while lowest mean incidence noticed in Chakrayapet (0.5%) mandal. The highest mean incidence dry root rot was recorded in Vempalli (12.5%) mandal, while the lowest mean incidence was noticed in Chakrayapet (7.1%) mandal. The highest mean incidence of stem rot was recorded in the Lakkireddipalli (10.1%) mandal, while the lowest mean incidence was noticed in Chinnaganjam (7.1%) mandal. The district mean incidence of collar rot, dry root rot and stem rot incidence was recorded as 3.6, 9.7 and 5.7% respectively (Table.2).

In Kurnool district the highest mean incidence of collar rot incidence was recorded in Gonegandla mandal (5.4%), while the lowest mean incidence was noticed in Pattikonda and Krishnagiri (0.5%) mandal. The highest mean incidence of dry root rot was recorded in Yemmiganur (11.2%) mandal, while the lowest mean incidence was noticed in Veldurthi (4.7%) mandal. The highest mean stem rot incidence was recorded in the Devana Konda (4.9%) mandal, while the lowest mean incidence was noticed in Veldurthi (1.1%) mandal. The mean incidence of the collar rot, dry root rot and stem rot was recorded in the district as 2.3, 6.8 and 3.6% respectively (Table.2). In SPSR Nellore district the highest mean incidence of collar rot was recorded in Sangam mandal (7.8%), while lowest average incidence noticed in Bogelu (1.7%) mandal. The highest mean incidence of dry root rot was recorded in Muttukur (12.4%) mandal, while the lowest mean incidence was noticed in Vakadu (2.0%) mandal. The highest mean incidence of stem rot was recorded in the Kavali (16.1%) mandal, while the lowest mean incidence was noticed in Vakadu (0.9%) mandal. The mean incidence of collar rot, dry root rot and stem rot incidence was recorded in the district as 5.6, 7.1 and 6.0% respectively (Table.2).

Based on the survey data obtained from the five districts *viz*., during *Rabi* 2020-21. It was evident that the maximum collar rot incidence was recorded in the Anantapuramu district (7.9%) followed by the SPSR Nellore (7.1%). The minimum collar rot incidence was observed in the Kurnool district (2.3%) (Table.2). The maximum dry root rot incidence was recorded in the Chittoor district (9.9%) followed by the YSR Kadapa (9.7%). The Minimum dry root rot incidence was observed in the SPSR Nellore (5.6%). The maximum stem rot incidence was recorded in the Anantapuramu district (8.0%) followed by the SPSR Nellore (6.0%). The Minimum stem rot incidence was observed in the Kurnool district (3.6%) (Table.2).

Rajamohan *et al*. (2012) [12] conducted a survey in dry root rot of groundnut in Cuddalore region of Tamilnadu and recorded the maximum disease incidence of 31.68% on the cultivars like VRI2, JL24. In their study they also noticed the disease was more in sandy loam soils and rain fed conditions.

Nandeesha *et al*. (2013) [9] also noticed the highest incidence of collar rot in Srikalahasti mandal (11.21%), whereas least incidence of 6.47 percent in Chandragiri mandal during their roving survey conducted during 2012 in tirupati and surrounding mandals of the chandragiri. Similar results were also obtained by Srinivas, (2016) [15] in their studies by conducting a roving survey during *rabi* 2014 in different chickpea growing areas of central (Madhya Pradesh and Maharashtra) and southern (Andhra Pradesh, Telangana and Karnataka) India and reported the maximum dry root rot incidence in Telangana (18.28%) followed by Madhya Pradesh (18.10%). This was followed by Karnataka (7.85%), Andhra Pradesh (5.40%) and the least in Maharashtra (5.38%). Mohanapriya *et al*. (2017) [8] surveyed for the dry root rot incidence of cowpea in Cuddalore, Thiruvannamalai and Vellore districts of Tamil Nadu and observed the dry root rot is endemic among different locations surveyed for cowpea root rot incidence and Sukkanampatti (MP10) registered the maximum incidence of the disease (25.84%) followed by Keelakapoondi, Keeranur and Sivapuri. This survey also revealed that higher levels of disease incidence were observed in rainfed than that of irrigated crop. The dry condition is more prevalent in the rainfed conditions might have favoured the pathogen which could be attributed as the reason for the higher level of disease incidence.

Divya Rani *et al*. (2016) [11] reported the similar kinds of results by conducting a survey in major groundnut growing areas of Andhra Pradesh during *kharif* 2012 and in Telangana during *rabi* 2012-13 respectively. In their study found the groundnut cultivar Kadiri 6 was the prominent in all the surveyed districts. The highest incidence of stem rot and collar rot were observed in Chittoor district of Andhra Pradesh. Whereas, lowest incidences of stem rot and collar rot were observed in Mahbubnagar and Warangal districts respectively. Similarly Ramanjineyulu *et al*. (2017) [13] conducted a roving survey during *Kharif*-2020 and noticed the stem rot or pod rot incidence in Chittoor district as 11.4 to 28.6 percent, where in Anantapur it was ranged from 8.5 to 30.0%. Amrutha *et al*., (2019) [1] noticed the highest dry root incidence in Anantapuramu and highest stem rot incidence in SPSR Nellore and Chittoor and collar rot incidence in Kadapa districts respectively during their survey in *Kharif*-2020. Thirunarayanan *et al*. (2020) [16] revealed the dry root rot of sesame caused by *M. phaseolina* was ranged from 13.60 to 34.65 percent. Paramasivan *et al*. (2022) [10] found the groundnut root rot (24.35%) was highest at Chettinad in Sivagangai district, Stem rot (18.38%) at Sevur in Sivagangai district, late leaf spot (23.56%) and rust disease (32.42%) high in Sivagangai district comparing to other district surveyed.

Table 1: Occurrence and distribution of collar rot (CR), dry root rot (DRR) and stem rot (SR) of Groundnut in Andhra Pradesh during *Kharif*-2020

S. No	Name of the district	Name of the mandal	Name of the village	GPS coordinates	Name of the variety	Previous crop grown	Rainfed/ Irrigated	Percent disease incidence (%)		
								CR	DRR	SR
1.	Anantapuramu	Kadiri	Kadiri	14.110457, 78.146121	Kadiri 6	Groundnut	Rainfed	8.0	10.3	9.2
			Patnam	14.225578, 78.092277	K. Lepakshi	Groundnut	Rainfed	6.2	11.1	3.7
		Mean						**7.0**	**10.8**	**6.4**
		Nallamada	Boggulavari Palli	14.124142, 78.033642	Kadiri 6	Groundnut	Rainfed	4.4	10.0	10.1
			Charupalli	14.168655, 78.086378	Kadiri 6	Groundnut	Rainfed	5.0	10.9	5.8
		Mean						**4.7**	**10.4**	**7.9**
		Nallacheruvu	Maddimadugu	14.025831, 78.179172	K. Lepakshi	Groundnut	Rainfed	7.8	5.3	3.7
			Panthulacheruvu	14.059127, 78.170730	Kadiri 6	Groundnut	Rainfed	5.5	9.8	4.5
		Mean						**6.6**	**7.5**	**4.0**
		Mudigubba	Sanevaripalli	14.273932, 78.060458	Kadiri 6	Sorghum	Rainfed	4.3	8.1	2.2
			Sankepalli	14.399710, 77.948781	Kadiri 6	Groundnut	Rainfed	5.7	10.6	4.9
		Mean						**5.0**	**9.3**	**3.5**
		Battalapalli	Bathalapalli	14.536339, 77.742526	TMV-2	Groundnut	Rainfed	3.4	8.3	7.1
			Sanjeevapuram	14.546410, 77.734858	Kadiri 6	Groundnut	Rainfed	3.2	10.4	8.4
		Mean						**3.3**	**9.3**	**7.7**
		Gooty	Gooty	15.117898, 77.660286	Kadiri 6	Groundnut	Rainfed	1.2	5.6	4.5
			Basinepalle	15.175478, 77.607996	Kadiri 6	Sorghum	Rainfed	1.9	11.6	7.5
		Mean						**1.5**	**8.6**	**5.6**
		Talupula	Talupula	14.246130, 78.249348	Kadiri 6	Groundnut	Rainfed	1.1	9.4	11.3
			P. annagaripalle	14.255947, 78.329187	Kadiri 6	Groundnut	Rainfed	4.5	2.4	10.5
		Mean						**2.8**	**5.9**	**10.9**
		Bukkarayasamudram	Govindapalle	14.738558, 77.603310	Kadiri 6	Bajra	Rainfed	3.2	9.3	8.0
			Danduvaripalle	14.678620, 77.666676	Kadiri 6	Groundnut	Rainfed	4.9	7.6	6.2
		Mean						**4.0**	**8.4**	**7.0**
		Gandlapenta	Gandlapenta	14.081014, 78.339951	Kadiri 6	Groundnut	Rainfed	3.2	10.4	8.0
			Veparala	14.093901, 78.299679	Kadiri 6	Tomato	Rainfed	2.4	8.7	7.4
		Mean						**2.9**	**9.6**	**7.7**
		District Mean						**4.2**	**8.9**	**6.9**
2.	Chittoor	Mulakala cheruvu	M. cheruvu	13.791414, 78.267094	Kadiri 6	Tomato	Rainfed	2.1	9.4	4.0
			N. cheruvupalle	13.741639, 78.216105	K. Amaravathi	Groundnut	Irrigated	4.9	11.3	9.7
		Mean						**3.4**	**10.3**	**6.9**
		Pedda Tippa Samudram (P.T.M)	P.T.M	13.755730, 78.309745	Kadiri 6	Groundnut	Rainfed	4.1	5.3	11.6
			Rangasamudram	13.739995, 78.266217	Kadiri 6	Groundnut	Rainfed	1.8	9.2	2.8
		Mean						**2.9**	**7.3**	**7.2**
		Thamballapalle	Kannemadugu	13.762838, 78.494933	Kadiri 6	Rice	Rainfed	2.3	4.4	2.4
			Thamballapalle	13.823467, 78.441690	Kadiri 6	Groundnut	Rainfed	1.3	3.5	1.3
		Mean						**1.8**	**3.9**	**1.8**
		Punganur	Punganur	13.466072, 78.539763	Dharani	Groundnut	Irrigated	2.2	5.4	3.2
			Chadalla	13.383422, 78.598115	Kadiri 6	Groundnut	Rainfed	1.1	5.5	2.0
		Mean						**1.6**	**5.4**	**2.6**
		Chowdepalle	Chowdepalle	13.436654, 78.703161	Kadiri 6	Groundnut	Irrigated	4.4	6.5	5.3
			Pudipatla	13.406402, 78.659667	Kadiri 6	Groundnut	Rainfed	2.3	5.6	2.2
		Mean						**3.3**	**6.0**	**3.7**

		Somala	Somala	13.480284, 78.813842	Kadiri 6	Rice	Irrigated	5.1	6.2	8.4
			S nadimpalle	13.493158, 78.835965	Kadiri 6	Groundnut	Rainfed	2.1	6.1	3.0
		Mean						**3.6**	**6.1**	**5.7**
		Sadum	Sadum	13.547308, 78.910567	Kadiri 6	Groundnut	Irrigated	5.3	8.5	0.0
			Chintalavari palle	13.571546, 78.923939	Kadiri 6	Groundnut	Irrigated	6.2	5.1	0.0
		Mean						**5.7**	**6.8**	**-**
		Pileru	Jandla	13.688613, 78.966018	Narayani	Groundnut	Rainfed	11.1	10.0	2.2
			Vepula Byalu	13.661098, 78.892930	Kadiri 6	Tomato	Rainfed	9.8	8.7	3.2
		Mean						**10.4**	**9.3**	**2.6**
		Rompicherla	Rompicherla	13.665061, 79.047431	Kadiri 6	Groundnut	Rainfed	2.2	9.3	3.6
			Peddamallela	13.688089, 79.038174	Dharani	Groundnut	Rainfed	6.0	9.0	3.4
		Mean						**4.1**	**9.1**	**3.5**
		Vayalpadu	Vayalpadu	13.633046, 78.618835	Narayani	Groundnut	Rainfed	1.1	2.2	2.2
			Chintaparthi	13.641906, 78.695026	Kadiri 6	Redgram	Rainfed	1.0	4.1	0.9
		Mean						**1.0**	**3.1**	**1.5**
		District Mean						**3.8**	**6.7**	**3.5**
3.	YSR Kadapa	Galiveedu	Eguva Kunta	14.009526, 78.575497	Kadiri 6	Groundnut	Rainfed	2.2	9.2	9.4
			Pandilla Palle	14.139810, 78.589407	Kadiri 6	Groundnut	Rainfed	1.0	5.6	3.1
		Mean						**1.6**	**7.4**	**6.2**
		Rayachoti	Gorlamudiveedu	14.028748, 78.668646	Kadiri 6	Groundnut	Irrigated	2.1	6.2	16.6
			Cherlopalli	14.022311, 78.725661	TMV-2	Groundnut	Rainfed	4.2	6.3	8.3
		Mean						**3.1**	**6.2**	**12.4**
		Chinnamandem	Vandadi	13.998400, 78.723111	Kadiri 6	Groundnut	Irrigated	3.6	4.6	0.0
			Diguvagottiveedu	14.008148, 78.609906	Kadiri 6	Groundnut	Rainfed	1.0	3.3	3.4
		Mean						**2.2**	**4.0**	**1.7**
		T Sundupalli	T Sundapalli	13.990644, 78.898281	Kadiri 6	Groundnut	Irrigated	1.2	9.9	6.2
			Polimerapalli	14.114303, 78.758256	Kadiri 6	Groundnut	Rainfed	3.3	5.3	5.9
		Mean						**2.2**	**7.6**	**6.0**
		Lakkireddy palli	Lakkireddy palli	14.178972, 78.704707	Kadiri 6	Groundnut	Rainfed	1.1	7.8	7.7
			Dappepalle	14.189694, 78.629354	Kadiri 6	Groundnut	Rainfed	2.1	9.7	11.7
		Mean						**1.6**	**8.8**	**9.7**
		Vempalli	Vempalli	14.358810, 78.452538	K. Lepakshi	Groundnut	Rainfed	2.9	9.1	0.0
			Muttukur	14.468004, 78.429789	Kadiri 6	Groundnut	Rainfed	3.3	8.4	8.8
		Mean						**3.1**	**8.8**	**4.3**
		VNP	Ayyavaripalle	14.549949, 78.499495	Kadiri 6	Groundnut	Irrigated	4.5	7.3	2.1
			Animela	14.493654, 78.478515	Kadiri 6	Groundnut	Rainfed	4.0	15.7	14.6
		Mean						**4.2**	**11.6**	**8.4**
		Thondur	Inagalur	14.536681, 78.261968	Kadiri 6	Groundnut	Rainfed	2.4	3.4	0.0
			Thondur	14.569984, 78.279072	Kadiri 6	Groundnut	Rainfed	11.1	3.8	0.0
		Mean						**6.7**	**3.7**	**-**
		Veeraballi	Veeraballi	14.153950, 78.869655	Kadiri 6	Tomato	Rainfed	6.7	6.3	8.6
			Gadikota	14.156252, 78.866820	Kadiri 6	Groundnut	Irrigated	5.8	7.5	1.0
		Mean						**6.3**	**7.0**	**4.9**
		District Mean						**3.5**	**7.2**	**6.0**
4.	Kurnool	Dhone	Devarabanda	15.342083, 77.812575	Kadiri 6	Groundnut	Rainfed	2.3	7.1	0.0
			Dhone	15.381870, 77.840371	Kadiri 6	Groundnut	Rainfed	4.5	10.5	6.8
		Mean						**3.4**	**8.9**	**3.4**

		Veldurthi	Veldurthi	15.553712, 77.923229	Kadiri 6	Cotton	Irrigated	4.8	3.6	2.4
			Cherukulapadu	15.525411, 77.885226	Kadiri 6	Groundnut	Rainfed	0.0	2.4	0.0
		Mean						**2.4**	**3.0**	**1.2**
		Krishnagiri	Krishnagiri	15.554302, 77.822808	Kadiri 6	Cotton	Rainfed	2.3	2.3	1.2
			Yerukala cheruvu	15.555993, 77.763071	Kadiri 6	Bajra	Irrigated	1.3	1.1	0.0
		Mean						**1.9**	**1.7**	**0.6**
		Devana Konda	Pedda Kota Konda	15.631735, 77.687964	Kadiri 6	Groundnut	Rainfed	2.4	9.4	2.4
			Devana Konda	15.533514, 77.545498	Kadiri 6	Groundnut	Rainfed	2.2	15.5	4.5
			Kukati Konda	15.505538, 77.537151	Kadiri 6	Groundnut	Irrigated	4.4	16.7	12.6
		Mean						**3.3**	**16.0**	**8.5**
		Peapally	Pothidoddi	15.200026, 77.711437	Kadiri 6	Groundnut	Irrigated	3.8	6.3	2.5
			Peapally	15.223219, 77.728241	Kadiri 6	Groundnut	Irrigated	9.5	7.2	2.4
		Mean						**6.6**	**6.8**	**2.4**
		Yemmiganur	Ralladoddi	15.727474, 77.577848	Kadiri 6	Groundnut	Irrigated	7.2	10.9	2.4
			Yemmiganur	15.767532, 77.501353	Kadiri 6	Groundnut	Rainfed	2.2	8.4	1.1
		Mean						**4.7**	**9.7**	**1.8**
		Gonegandla	Iranbanda	15.711493, 77.609774	Kadiri 6	Groundnut	Rainfed	0.9	0.9	4.3
			H. Kairawadi	15.705759, 77.652829	Kadiri 6	Onion	Rainfed	1.0	1.8	2.6
		Mean						**0.9**	**0.9**	**4.3**
		Pattikonda	Pandikona	15.440889, 77.561748	Kadiri 6	Groundnut	Irrigated	4.6	11.2	12.6
			Dudekonda	15.434790, 77.514774	Kadiri 6	Groundnut	Rainfed	2.2	10.1	3.4
		Mean						**3.4**	**10.7**	**8.0**
		Tuggali	Tuggali	15.309236, 77.547291	Kadiri 6	Chickpea	Rainfed	1.0	4.5	3.5
			Ratana	15.351938, 77.526116	Kadiri 6	Groundnut	Rainfed	1.0	10.2	2.0
		Mean						**0.9**	**7.4**	**2.8**
		District Mean						**3.0**	**7.3**	**3.6**
5.	SPSR Nellore	Kovur	Gummalladibba	14.508837, 79.969560	TAG-24	Vegetables	Irrigated	11.2	7.4	2.1
			Patur	14.513602, 79.929840	TAG-24	Colocasia	Irrigated	5.0	5.9	11.9
		Mean						**8.1**	**6.7**	**6.9**
		Sangam	P. Palli palem	14.574848, 79.765765	TAG-24	Groundnut	Irrigated	12.0	10.0	3.0
			Makthapuram	14.557841, 79.798311	TAG-24	Groundnut	Rainfed	6.8	15.9	10.7
		Mean						**9.4**	**12.9**	**6.8**
		Chejerla	Pelleru		TAG-24	Groundnut	Irrigated	3.9	6.0	1.9
			Mamuduru	14.570820, 79.686054	Kadiri 6	Watermelon	Rainfed	2.7	6.2	1.8
		Mean						**3.2**	**6.0**	**1.9**
		Podalakur	Surayapalem	14.570910, 79.737345	TAG-24	Groundnut	Irrigated	4.6	4.5	0.0
			Thatiparthi	14.489417, 79.804278		Groundnut	Irrigated	2.0	6.0	1.0
		Mean						**3.3**	**5.2**	**0.4**
		Muttukur	Pidathapolur	14.351556, 80.088778	Kadiri 6	Groundnut	Irrigated	9.4	5.6	0.0
			Muttukur	14.351529, 80.064009	TAG-24	Groundnut	Irrigated	3.7	2.7	0.0
		Mean						**6.5**	**4.1**	**-**
		Vidavalur	Utukur	14.589205, 80.144950	TAG-24	Groundnut	Irrigated	2.1	9.1	7.8
			Varini	14.607035, 80.140628	TAG-24	Groundnut	Irrigated	2.0	3.2	3.1
		Mean						**2.0**	**6.1**	**5.4**
		Bogolu	Bitragunta	14.783142, 79.953437	TAG-24	Groundnut	Irrigated	2.1	3.1	0.0
			Bogolu	14.756134, 79.925626	TAG-24	Groundnut	Rainfed	3.0	2.0	3.9
		Mean						**3.6**	**4.1**	**3.5**

		Dagadarthi	Katrayapadu	14.704718, 79.882164	TAG-24	Groundnut	Irrigated	4.0	4.5	0.0
			Dagadarthi	14.668136, 79.921266	Kadiri 6	Groundnut	Rainfed	3.1	8.1	0.0
		Mean						**5.0**	**7.2**	**1.9**
		Kavali	Ammavari palem	14.848224, 80.065575	Kadiri 6	Groundnut	Irrigated	8.6	13.2	5.5
			Tummalapenta	14.897775, 80.063614	Kadiri 6	Groundnut	Irrigated	3.2	4.0	3.3
		Mean						**7.4**	**12.6**	**4.3**
		District Mean						**5.4**	**7.3**	**4.3**

Table 2: Occurrence and distribution of collar rot (CR), dry root rot (DRR), stem rot (SR) of Groundnut in Andhra Pradesh during Rabi 2020-21

S. No.	Name of the district	Name of the mandal	Name of the village	GPS Coordinates	Name of the variety	Previous crop grown	Rainfed/ Irrigated	Percent disease incidence (%)		
								CR	DRR	SR
1.	Anantapur	Kadiri	Kadiri	14.111506, 78.146677	Kadiri 6	Groundnut	Rainfed	3.2	10.5	11.4
			Varigireddy Palli	14.115682, 78.118567	K. Lepakshi	Groundnut	Rainfed	4.4	9.5	7.5
		Mean						**9.6**	**5.3**	**8.5**
		Nallamada	Nallamada	14.180339, 78.000281	Kadiri 6	Groundnut	Rainfed	6.4	9.7	9.6
			Buggalapalli	14.146250, 78.094743	Kadiri 6	Groundnut	Rainfed	5.6	12.4	15.9
		Mean						**6.4**	**10.3**	**13.7**
		Nallacheruvu	Nallacheruvu	14.025831, 78.179172	K. Lepakshi	Groundnut	Rainfed	7.2	8.3	11.6
			Allugundu	14.059127, 78.170730	Kadiri 6	Groundnut	Rainfed	1.3	11.1	7.5
		Mean						**5.8**	**8.6**	**6.4**
		O.D.C	Kondakamarla	14.082050, 77.964407	Kadiri-7 Bold	Tomato	Irrigated	10.4	6.2	5.3
			Inagaluru	14.067114, 78.050750	Kadiri 6	Groundnut	Irrigated	5.0	5.1	13.7
		Mean						**4.3**	**8.9**	**10.4**
		Bukkapatnam	N. Palli thanda	14.203765, 77.783725	Kadiri 6	Groundnut	Rainfed	3.6	12.9	6.3
			Bukkapatnam	14.192019, 77.795956	K. Amaravathi	Groundnut	Irrigated	2.2	12.6	9.4
		Mean						**1.7**	**7.9**	**12.2**
		Puttaparthi	Kotlapalle	14.079264, 77.771729	K. Amaravathi	Groundnut	Rainfed	1.2	3.3	15.2
			Pedaballi	14.058880, 77.783033	Kadiri-7 Bold	Groundnut	Irrigated	2.8	14	5.7
		Mean						**3.7**	**12.0**	**8.4**
		Gorantla	Gownivaripalli	13.967880, 77.887811	Kadiri 6	Groundnut	Irrigated	4.7	10.2	11.2
			Mareddipalle	13.971386, 77.798961	Kadiri 6	Tomato	Rainfed	4.5	6.9	8.1
		Mean						**4.0**	**9.2**	**8.3**
		Talupula	Batrepalli	14.265079, 78.307886	Kadiri 6	Groundnut	Irrigated	3.7	11.7	8.6
			Gunduvaripalli	14.271949, 78.320671	Kadiri 6	Groundnut	Rainfed	3.1	8.3	8.1
		Mean						**1.5**	**4.1**	**4.0**
		District Mean						**7.7**	**7.9**	**8.0**
2.	Chittoor	Mulakala cheruvu	K. Adhunikota	13.786690, 78.279113	Kadiri-7 Bold	Tomato	Irrigated	5.8	7.6	2.8
			N. Cheruvu palle	13.741639, 78.216105	Kadiri 6	Groundnut	Rainfed	4.1	14.0	3.5
		Mean						**4.9**	**10.9**	**3.1**
		Pedda Tippa Samudram (P.T.M)	Pullikallu	13.799686, 78.263614	Kadiri 6	Groundnut	Irrigated	3.3	8.1	3.4
			Maddaiahgaripalle	13.741639, 78.216105	K. Lepakshmi	Groundnut	Rainfed	7.1	22.0	0.0
		Mean						**5.2**	**15.0**	**1.1**
		B Kothakota	B Kothakota	13.658835, 78.255980	Kadiri-7 Bold	Tomato	Irrigated	4.9	7.3	12.8
			Gattuvaripalem	13.663815, 78.351618	Kadiri 6	Tomato	Rainfed	5.4	16.5	10.9
		Mean						**5.1**	**11.9**	**11.8**
		Kurabalakota	Angallu	13.661373, 78.452637	Kadiri 6	Tomato	Rainfed	3.2	16.8	0.0

			Upparapalle	13.638301, 78.477106	Kadiri 6	Groundnut	Rainfed	6.5	8.2	3.6
		Mean						**4.8**	**12.5**	**1.8**
		Madanapalle	Kothavaripalle	13.617969, 78.544967	K. Amaravathi	Groundnut	Rainfed	10.0	4.9	0.0
			C.T.M	13.660456, 78.548774	Kadiri 6	Tomato	Irrigated	4.0	8.9	8.0
		Mean						**6.9**	**6.9**	**4.0**
		Somala	Somala	13.480284, 78.813842	Kadiri 6	Rice	Irrigated	4.1	8.2	6.0
			S nadimpalle	13.493158, 78.835965	Dharani	Tomato	Rainfed	3.1	4.8	0.0
		Mean						**3.6**	**6.5**	**3.0**
		Sadum	Sadum	13.547308, 78.910567	Kadiri 6	Groundnut	Rainfed	8.7	9.5	2.2
			Ammagari palle	13.544446, 78.899348	Kadiri 6	Groundnut	Irrigated	13.6	5.1	1.8
		Mean						**11.1**	**7.3**	**1.9**
		Pileru	Talupula	13.727517, 78.996656	Kadiri 6	Groundnut	Irrigated	3.5	11.2	2.2
			Pileru	13.671415, 78.956565	Kadiri 6	Groundnut	Rainfed	3.4	10.0	5.7
		Mean						**3.4**	**10.6**	**3.9**
		Rompicherla	Ganugachinta	13.773155, 79.049562	Dharani	Groundnut	Rainfed	2.4	8.4	12.9
			Rompicherla	13.669970, 79.051769	Dharani	Groundnut	Rainfed	2.2	8.9	5.4
		Mean						**2.2**	**8.6**	**9.1**
		Yerravaripalem	Yellamanda	13.795612, 79.045219	Kadiri 6	Groundnut	Irrigated	5.3	12.2	2.7
			Yerravaripalem	13.790124, 79.043124	Dharani	Groundnut	Rainfed	1.8	6.2	8.6
		Mean						**3.5**	**9.2**	**5.6**
		District Mean						**5.1**	**9.9**	**4.6**
3.	YSR Kadapa	Galiveedu	Araveedu	13.881121, 78.540353	K. e Lepakshmi	Groundnut	Irrigated	1.9	10.1	5.1
			Galiveedu	14.028748, 78.668646	Kadiri 6	Groundnut	Rainfed	8.8	8.6	4.2
		Mean						**5.3**	**9.3**	**4.6**
		Rayachoti	Gorlamudiveedu	14.020278, 78.650833	Kadiri 6	Groundnut	Irrigated	3.2	6.4	13.8
			Yandapalle	14.043467, 78.689570	Kadiri 6	Groundnut	Rainfed	1.1	9.1	2.4
		Mean						**2.1**	**7.8**	**8.1**
		Chinnaganjam	Vandadi	14.024850, 78.701805	Kadiri 6	Groundnut	Rainfed	4.2	10.6	1.0
			T sakibanda	14.018773, 78.631041	Kadiri 6	Groundnut	Rainfed	1.1	12.2	2.1
		Mean						**2.7**	**11.4**	**2.1**
		Chakrayapet	Gandi Kovur	14.273892, 78.490974	Kadiri 6	Pulses	Irrigated	1.1	8.4	6.5
			Chilekampalli	14.253325, 78.504878	K. Lepakshmi	Groundnut	Rainfed	0.0	5.9	3.3
		Mean						**0.5**	**7.1**	**4.9**
		Lakkireddy palli	Maddirevula	14.194189, 78.688033	Kadiri 6	Groundnut	Irrigated	3.4	12.5	14.0
			Dappepalli	14.187141, 78.626824	K. Lepakshmi	Groundnut	Rainfed	3.1	7.3	6.2
		Mean						**3.3**	**9.9**	**10.1**
		Vempalli	Vempalli	14.427504, 78.466375	Kadiri 6	Groundnut	Rainfed	7.9	13.7	2.2
			Ramireddi Palle	14.462650, 78.412312	Kadiri 6	Groundnut	Rainfed	3.6	11.4	5.7
		Mean						**5.8**	**12.5**	**3.9**
		VNP	Payasam palli	14.537843, 78.507690	K. Lepakshmi	Groundnut	Rainfed	7.8	12.5	3.9
			Animela	14.513203, 78.486129	Kadiri 6	Groundnut	Irrigated	3.5	15.5	11.4
		Mean						**5.7**	**9.7**	**5.7**
		District Mean						**3.6**	**9.7**	**5.7**
4.	Kurnool	Yemmiganur	Errakota	15.754154, 77.553833	Kadiri 6	Cotton	Rainfed	2.7	12.6	2.6
			Yemmiganur	15.727474, 77.577848	Kadiri 6	Groundnut	Rainfed	2.1	9.8	2.1
		Mean						**2.4**	**11.2**	**2.3**
		Gonegandla	Iranbanda	15.709797, 77.609759	Kadiri 6	Groundnut	Rainfed	7.8	4.8	6.6

			H. Kairawadi	15.705705, 77.648991	Kadiri 6	Groundnut	Rainfed	3.1	5.3	3.0
		Mean						**5.4**	**5.0**	**4.8**
		Pattikonda	Pattikonda	15.440889, 77.561748	Kadiri 6	Groundnut	Rainfed	0.9	9.1	4.8
			Dudekonda	15.447050, 77.539653	Kadiri 6	Cotton	Rainfed	0.0	7.4	4.3
		Mean						**0.5**	**8.3**	**4.5**
		Tuggali	Ratana	15.348788, 77.528597	Kadiri 6	Chickpea	Rainfed	2.2	7.6	10.1
			Jonnagiri	15.175478, 77.607996	Kadiri 6	Groundnut	Rainfed	4.2	6.5	2.1
		Mean						**3.2**	**7.0**	**6.0**
		Veldurthi	Veldurthi	15.555277, 77.921670	Kadiri 6	Groundnut	Irrigated	2.1	4.4	1.1
			Cherukulapadu	15.525411, 77.885226	Kadiri 6	Groundnut	Rainfed	1.3	5.0	0.0
		Mean						**1.6**	**4.7**	**1.1**
		Krishnagiri	Krishnagiri	15.554302, 77.822808	Kadiri 6	Groundnut	Rainfed	1.2	4.3	1.1
			Yelukala cheruvu	15.555993, 77.763071	Kadiri 6	Tomato	Irrigated	0.0	6.4	3.0
		Mean						**0.5**	**5.3**	**2.0**
		Devana Konda	Pedda Devana Konda	15.597659, 77.690150	Kadiri 6	Groundnut	Rainfed	3.6	4.9	2.4
			Devanakonda	15.535878, 77.546006	Kadiri 6	Groundnut	Rainfed	1.2	7.0	7.4
		Mean						**2.3**	**5.9**	**4.9**
		District Mean						**2.3**	**6.8**	**3.6**
5.	SPSR Nellore	Sangam	P. Palli palem	14.571073, 79.773370	Kadiri-7 Bold	Groundnut	Rainfed	10.9	6.7	2.0
			Makthapuram	14.557841, 79.798311	TAG-24	Cluster bean	Irrigated	4.7	8.5	5.4
		Mean						**7.8**	**7.6**	**3.7**
		Utukur	Utukur	14.589205, 80.144950	TAG-24	Groundnut	Rainfed	7.8	7.2	6
			Varini	14.607035, 80.140628	TAG-24	Groundnut	Irrigated	3.1	10.9	11.1
		Mean						**5.4**	**9.0**	**8.6**
		T.P Gudur	Venkannapalem	14.435389, 80.150982	TAG-24	Groundnut	Irrigated	5.4	8.6	4.4
			Varakavipudi	14.363096, 80.115529	TAG-24	Groundnut	Rainfed	3.2	5.4	1.1
		Mean						**4.2**	**7.0**	**2.8**
		Muttukur	Mamidipudi	14.315038, 80.098233	TAG-24	Groundnut	Rainfed	7.5	15.0	0.0
			Muttukur	14.368559, 80.047328	TAG-24	Groundnut	Irrigated	7.1	9.8	2.0
		Mean						**7.3**	**12.4**	**1.0**
		Chillakur	Lingavaram	14.216363, 80.079360	Kadiri 6	Groundnut	Irrigated	7.7	5.4	8.8
			Ballavolu	14.137560, 80.046164	TAG-24	Groundnut	Irrigated	2.8	9.4	12.1
		Mean						**4.5**	**4.6**	**2.7**
		Kota	Sidapuram	14.085953, 80.097146	TAG-24	Groundnut	Rainfed	4.5	4.6	2.7
			Kottapatnam	14.138543, 80.120089	TAG-24	Groundnut	Rainfed	10.0	5.4	4.8
		Mean						**7.2**	**5.0**	**3.7**
		Vakadu	Yerragattu	14.007702, 80.062884	TAG-24	Groundnut	Irrigated	4.5	2.3	0.0
			Vakadu	14.005947, 80.062668	Kadiri 6	Groundnut	Irrigated	9.7	1.8	1.9
		Mean						**7.1**	**2.0**	**0.9**
		Bogolu	Venkatesupalem	14.769412, 80.060585	TAG-24	Groundnut	Rainfed	1.6	8.7	0.0
			Juvvaladinne	14.797793, 80.076228	TAG-24	Groundnut	Irrigated	1.8	6.6	13.3
			Mean					**1.8**	**7.6**	**6.6**
		Kavali	Annagaripalem	14.848224, 80.065575	Kadiri 6	Groundnut	Irrigated	3.9	7.5	15.2
			Tummalapenta	14.897775, 80.063614	TAG-24	Groundnut	Irrigated	4.0	4.8	16.9
		Mean						**3.9**	**6.1**	**16.0**
		District Mean						**5.6**	**7.1**	**6.0**

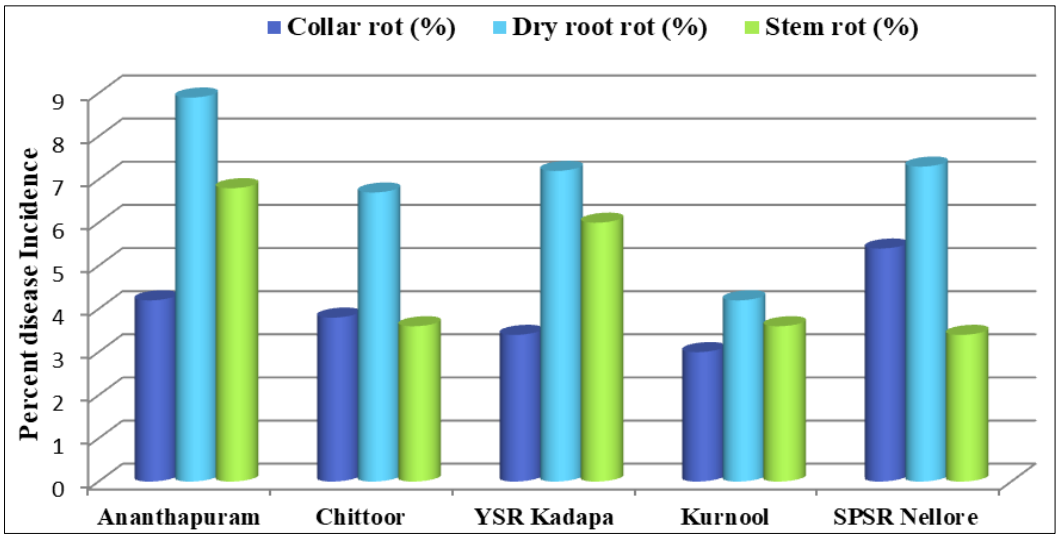

Fig 4: Collar rot (CR), Dry root rot (DRR) and Stem rot (SR) incidence in various districts of Andhra Pradesh during Kharif -2020

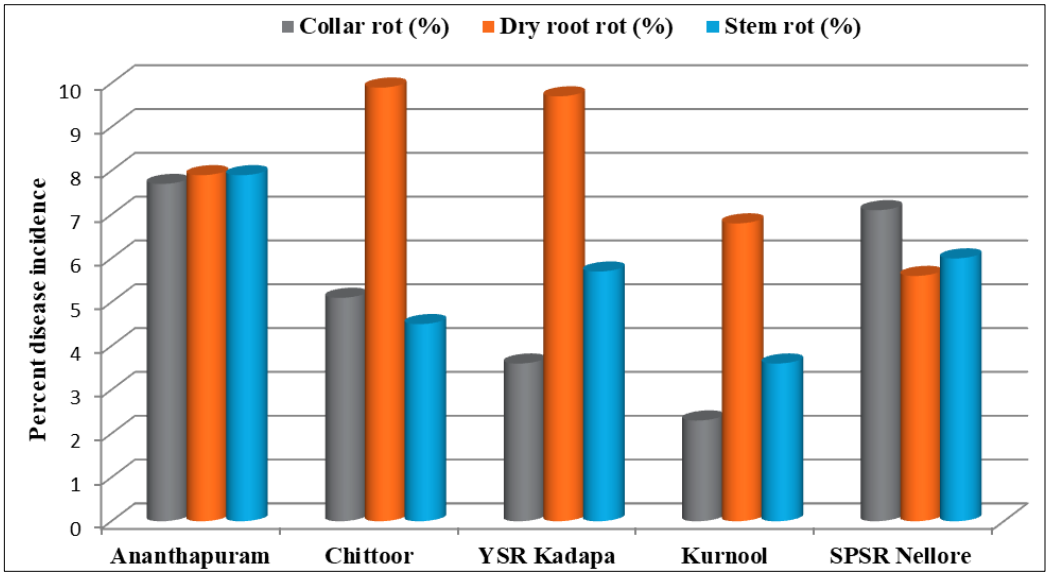

Fig 5: Collar rot (CR), Dry root rot (DRR) and Stem rot (SR) incidence in various districts of Andhra Pradesh during *Rabi* -2020-21

Conclusion

A roving survey was conducted during *Kharif* 2020and *Rabi* 2020-21 to know the occurrence and distribution of soil borne diseases of groundnut *viz*., the collar rot, dry root rot and stem rot diseases in various regions of the Rayalaseema of Andhra Pradesh. From the survey it was found that Kadiri-6 groundnut cultivar was grown predominantly in the Anantapur, Chittoor, YSR Kadapa and Kurnool districts. Whereas TAG-24 was predominant in SPSR Nellore region. In *Kharif*-2020 the collar incidence was ranged from 3.0 to 5.4%, dry root rot was ranged from the 6.7 to 8.9% and stem rot incidence was ranged from 3.4 to 6.8%. Where as in *Rabi* 2020-21 the collar incidence was ranged from 2.3 to 7.7%, dry root rot was ranged from the 7.9 to 5.6% and stem rot incidence was ranged from 3.6 to 7.8%. The dry root was observed more in the rainfed conditions compared to the irrigated conditions. It was also noticed that the soil type and age of the crop, rainfed or irrigation conditions were also important for occurrence of these diseases.

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